Ontario Geological Survey
Aggregate Resources Inventory Paper 1

AGGREGATE RESOURCES INVENTORY OF MONO TOWNSHIP DUFFERIN COUNTY SOUTHERN ONTARIO

1979

Ontario
Ministry of Natural Resources

Hon. James A.C. Auld
Minister

Dr. J.K. Reynolds
Deputy Minister

© OMNR-OGS 1979

Publications of the Ontario Ministry of Natural Resources, Geological Branch,
and price list
are obtainable through the
Ontario Ministry of Natural Resources, Map, Unit, Public Service Centre
Queen's Park, Toronto, Ontario
and
The Ontario Government Bookstore
880 Bay Street, Toronto, Ontario

Orders for publications should be accompanied by cheque
or money order, payable to the Treasurer of Ontario

ISSN 0708-2061
ISBN 0-7743-3629-3

This report was prepared by the staff of the Engineering and Terrain Geology Section of the Ontario Geological Survey, 77 Grenville St., Toronto, M5S 1B3, Telephone (416) 965-1182.

Project Supervisor: G.J. Burwasser
Text Prepared by: J.Z. Fraser
Compilation and Drafting by: C.M. Kwiatkowski

Parts of this publication may be quoted if credit is given to the Ontario Ministry of Natural Resources, Ontario Geological Survey. It is recommended that reference to this report be made in the following form:

Ontario Geological Survey
1979: Aggregate Resources Inventory of Mono Township, Dufferin County, Southern Ontario; Ontario Geological Survey, Aggregate Resources Inventory Paper 1, 31p. 6 tables, 3 maps, scale: 1:50,000.

700-78-U of T

CONTENTS

Page

Abstract V
Introduction. 1
Part I - Inventory Methods 1
Field and Office Methods 1
Resource Tonnage Calculation Techniques 2
Sand and Gravel Resources 2
Bedrock Resources 2
Units and Definitions 3
Part II - Data Presentation and Interpretation 3
Map 1 Distribution of Sand and Gravel Deposits 3
Map 2 Selected Sand and Gravel Resource Areas 4
Site Specific Criteria 4
Deposit Size 4
Aggregate Quality 4
Location and Setting 5
Regional Considerations 5
Map 3 Bedrock Resources 6
Selection Criteria. 6
Selected Resource Areas 6
Part III - Assessment of Aggregate Resources of Mono Township 8
Location and Population. 8
Physiography and Surficial Geology 8
Extractive Activity 9
Selected Sand and Gravel Resources 9
Selected Sand and Gravel Resource Area 1 10
Selected Sand and Gravel Resource Area 2 10
Selected Sand and Gravel Resource Area 3 11
Selected Sand and Gravel Resource Area 4 11
Selected Sand and Gravel Resource Area 5 11
Selected Sand and Gravel Resource Area 6 12
Sand and Gravel Resources of Secondary Significance 12
Bedrock Geology. 12
Selected Bedrock Resources 13
Amabel Formation 13
Selected Bedrock Resource Areas 1 and 2 13
Selected Bedrock Resource Areas 3 and 4 14
Summary. 14
Queenston Formation 14
Selected Bedrock Resource Areas 5 and 6 14
Selected Bedrock Resource Area 7 14
Summary. 14
References 23
Appendix A - General Reading. 25
Appendix B - Glossary 26
Appendix C - Geology of Sand and Gravel Deposits 28
Appendix D - Geology of Bedrock Deposits 30

TABLES

1 - Total Sand and Gravel Resources, Mono Township 15
2 - Sand and Gravel Pits, Mono Township. 16
3 - Selected Sand and Gravel Resources, Mono Township 19
4 - Total Identified Bedrock Resources, Mono Township. 20
5 - Quarries, Mono Township. 21
6 - Selected Bedrock Resource Areas, Mono Township 22

FIGURES

1 - Key Map Showing Location of Mono Township V
2 - Bedrock Geology of Southern Ontario 30

MAPS
(back pocket)

1 - Distribution of Sand and Gravel Deposits, Mono Township.
Scale 1:50,000.
2 - Selected Sand and Gravel Resource Areas, Mono Township.
Scale 1:50,000.
3 - Bedrock Resources, Mono Township.
Scale 1:50,000.

ABSTRACT

Figure 1 - Key Map Showing Location of Mono Township. Scale 1:800,000.

An inventory and evaluation of aggregate resources, including crushed stone derived from bedrock as well as natural sand and gravel, was completed for Mono Township in 1978, as part of the Aggregate Resources Inventory Program for townships and municipalities designated under the Ontario Pits and Quarries Control Act (1971). The aggregate resources in the township have been assessed in the context of a standardized inventory and evaluation methodology developed for the Program.

In Mono Township, six Areas containing significant amounts of sand and gravel have been selected for possible resource protection. Selected Sand and Gravel Resource Areas comprise 3685 acres (1491 ha) and are estimated to contain possible resources of 216 million tons (196 million tonnes). It is estimated that 182 million tons (165 million tonnes) are available for extraction under present conditions. The Selected Areas comprise 7 percent of the total area occupied by sand and gravel in Mono Township and 6 percent of the total resource tonnage.

Selected Sand and Gravel Resource Area 1, near the Town of Orangeville, constitutes the most important natural aggregate deposit in the township. This outwash deposit contains available resources of 28 million tons (25 million tonnes) of sand and crushable gravel suitable for a wide range of road-building and construction uses.

Selected Resource Areas 2 and 3 occupy portions of two large meltwater channel deposits at the southern and northern boundaries of the township. Possible resources in the Areas are estimated to be 50 million tons (45 million tonnes). Selected Resource Area 4 occupies 1422 acres (576 ha) in the Hockley Valley outwash deposit, and has possible resources estimated to be 90 million tons (82 million tonnes). The aggregate in Area 4 is suitable for a variety of uses. Selected Resource Areas 5 and 6 in the western and southwestern portions of the township, occupy 409 acres (165 ha) and have combined resources of 14 million tons (13 million tonnes). The aggregate from Area 6 is of high quality and is suitable for specialty uses.

Generally, Mono Township has large possible resources of sand and gravel, and is an important regional source of road-building and construction material. Care should be taken to ensure the continuing availability of as much of these resources as possible.

Possible resources derived from bedrock formations in Mono Township are of two types. Stone from the Amabel Formation is suitable for most road-building and construction aggregates. The Amabel Formation is an important regional source for high-quality crushed stone. Four Areas have been selected for possible resource protection. The Areas cover 1074 acres (435 ha) and contain possible resources of 212 million tons (192 million tonnes).

Shale from the Queenston Formation is suitable for brick and tile manufacture. The Queenston Formation is an important regional source for the construction industry, especially for residential construction. Three Areas have been selected for possible resource protection. The Areas occupy 2124 acres (860 ha) and contain possible resources of 359 million tons (326 million tonnes).

A Selected Resource Area should not be considered as providing a permanent, single, land-use unit for incorporation in an official planning document. It represents an area in which a major resource is known to exist. Such a resource area may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

AGGREGATE RESOURCES INVENTORY OF MONO TOWNSHIP

INTRODUCTION

Mineral aggregates, which include bedrock-derived crushed stone as well as naturally formed sand and gravel, constitute the major raw material in Ontario's road-building and construction industries. Very large amounts of these materials are used each year throughout the Province. For example, in 1976, the total tonnage of mineral aggregates extracted was greater than that of any other metallic or non-metallic commodity mined in the Province (Ontario Ministry of Natural Resources 1977).

Although mineral aggregate deposits are plentiful in southern Ontario, they are fixed-location, non-renewable resources which can be exploited only in those areas where they occur. Mineral aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as its quality and size. The potential for extractive development is often greatest in urban fringe areas where land-use competition is extreme. For these reasons the availability of adequate resources for future development is now being threatened in some areas.

Comprehensive planning and resource management strategies are required to make the best use of available resources, especially in those areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate resource base at both local and regional levels. The purpose of the Aggregate Resource Inventory is to provide the basic geological information required to include potential mineral aggregate resource areas in planning strategies and official plans. The reports should form the basis for discussion of those areas best suited for possible extraction. The aim is to assist decision-makers in protecting the public well-being by ensuring that adequate resources of mineral aggregate remain available for future use.

It is important to realize that this report is a technical background document, based for the most part on geological information and interpretation. It has been designed as a component of the total planning process and should be used in conjunction with other planning considerations, to ensure the best use of a municipality's resources.

The report includes an assessment of sand, gravel and crushed bedrock. The most recent information available has been used to prepare the reports. As new information becomes available revisions may be necessary.

Interested groups and individuals are invited to discuss any aspect of this report with staff geologists of the Ontario Geological Survey and with staff of the appropriate Regional and District Offices of the Ontario Ministry of Natural Resources.

PART I - INVENTORY METHODS

Field and Office Methods

The methods used to prepare the report primarily involve the interpretation of published geological data such as bedrock and surficial geology maps and reports (see References). Whenever possible, field examination of potential resource areas was also undertaken to confirm interpretations made in the office. Field methods included the examination of natural and man-made exposures of granular material. Most observations were made at quarries and sand and gravel pits located from records held by the Ontario Ministry of Transportation and Communications, the Ontario Geological Survey, and the Regional and District Offices of the Ontario Ministry of Natural Resources. Observations made at pit sites included estimates of the total face height and the proportion of gravel and sand size fragments in the deposit. Observations were also made of the shape and lithology of the particles. These characteristics are important in estimating the quality and quantity of the aggregate. In areas of limited exposure test pitting, soil probing and hand-augering techniques were used to assess subsurface

materials. Air photos at various scales were used to determine the continuity of deposits, especially in areas of limited subsurface information.

In the office, the pit data were supplemented by information on file with the Aggregate Unit of the Ontario Ministry of Transportation and Communications. Data contained in these files include field estimates of the depth, composition and workability of deposits as well as laboratory analyses of the physical properties and chemical suitability of the aggregate. Information concerning the development history of the pits and acceptable uses of the aggregate is also recorded. The location, size and depth of extraction of pits licenced under the Pits and Quarries Control Act (1971) were obtained from records held by Regional and District Offices of the Ontario Ministry of Natural Resources. The co-operation of the above named groups in the compilation of inventory data is gratefully acknowledged.

Water well records, held by the Ontario Ministry of the Environment, were used in some areas to corroborate thickness estimates, or to indicate the presence of buried granular material. These records were used only in conjunction with other evidence. Topographic maps of the National Topographic System, at a scale of 1:50,000 were used as a compilation base for the field and office data. The information was then transferred to a township base map, also at a scale of 1:50,000 prepared by the Cartography Section of the Lands and Waters Group, Ontario Ministry of Natural Resources, for presentation in the report.

Resource Tonnage Calculation Techniques

SAND AND GRAVEL RESOURCES

Once the interpretative boundaries of the aggregate units have been drawn, quantitative estimates of the possible resources available can be made. Generally, the volume of a deposit can be calculated if its areal extent and average thickness are known, or can be estimated. The computation methods used are as follows. First, the area of the deposit as outlined on the final base map is calculated in acres. The thickness values used are an approximation of the deposit thickness, based on the face heights of pits developed in the deposit or on subsurface data such as water well logs. Original tonnage values can then be calculated by multiplying the volume of the deposit by 2,500 which is approximately the number of tons in a one foot thick layer of sand and gravel, one acre in extent, assuming an average density of 110 pounds per cubic foot.

Original Tonnage = Area x Thickness x Density Factor

Portions of the Resource Area are then successively subtracted from the original figures to account for aggregate previously extracted and aggregate unavailable for extraction due to the presence of permanent cultural features such as towns, rural residential areas, roads, railways, and power lines, and due to setback requirements surrounding these features. The specific amount subtracted in each case is based on a qualitative estimate of field data, maps and air photos. The final tonnage figure shown on Table 3 is an estimate of the sand and gravel resources presently available for extraction in the deposit. The final figures were converted from Imperial units to Metric equivalents.

BEDROCK RESOURCES

The method used to calculate resources of bedrock-derived aggregate is much the same as that described above. The areal extent of favourable bedrock formations overlain by less than 50 feet (15 m) of unconsolidated overburden is determined from bedrock geology maps, drift thickness and bedrock topography maps and from the interpretation of water well records. The measured extent of such areas is then multiplied by the estimated workable thickness of the formation, based on stratigraphic analyses and on estimates of existing quarry faces in the unit. In some cases a standardized estimate of workable thickness of 60 feet (18 m) is used. Volume estimates are then multiplied by 3600- the estimated weight in tons of a one foot thick section of dolostone, one acre in extent, assuming a bulk density of 165 pounds per cubic foot.

Resources of sandstone are calculated using a bulk density estimate of 146 pounds per cubic foot or approximately 3200 tons per acre. Shale resources are also calculated on the basis of a bulk density estimate of 150 pounds per cubic foot. The final figures were converted from Imperial units to Metric equivalents.

UNITS AND DEFINITIONS

Although most of the measurements and other primary data available for resource tonnage calculations are given in Imperial units, Metric units have also been given in the text and on the tables which accompany the report. The Metric equivalent of the data is shown in brackets after or directly below the corresponding Imperial figures.

The tonnage estimates made for sand and gravel as well as bedrock-derived aggregates are termed possible resources in accordance with terminology of the Ontario Resource Classification Scheme (Robertson 1975, p.7) and with the Association of Professional Engineers of Ontario (1976) (see Glossary, Appendix B).

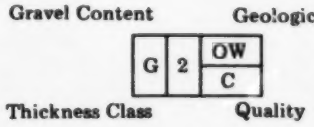
PART II – DATA PRESENTATION AND INTERPRETATION

Three maps, each portraying a different aspect of the aggregate resources in the munipicality, accompany the report. Map 1, Distribution of Sand and Gravel Deposits, gives a comprehensive inventory of the sand and gravel resources in the report area. Map 2, Selected Sand and Gravel Resources Areas, shows those deposits which are considered to represent the largest and/or highest quality resources in the area. Map 3, Bedrock Resource Areas, shows the distribution of bedrock formations, the distribu- of overlying unconsolidated sediments, and identifies the Selected Bedrock Resource Areas.

Map 1 Distribution of Sand and Gravel Deposits

Map 1 is derived directly from the existing surficial geology maps of the area or from air photo interpretation where surficial mapping is incomplete. It shows the extent of sand and gravel deposits within the study area and serves as a base for the calculation of the total sand and gravel resources listed in Table 1.

Map 1 presents a summary of all available information related to the quantity and quality of aggregate contained in all the known aggregate deposits in the study area. Much of this information is contained in the symbol which identifies each deposit. The Deposit Symbol is similar to those used in soil mapping and land classification systems commonly in use in North America. The components of the symbol indicate the gravel content, thickness of material, origin (type), and quality limitations for a given deposit. These components are illustrated by the following example:



This symbol identifies an outwash deposit 10 to 20 feet (3 to 6 m) thick containing more than 35 percent gravel. Excess fines may limit uses of the aggregate in the deposit.

The gravel content and thickness class are basic criteria for distinguishing different deposits. The gravel content symbol is an upper case S or G. The S indicates that the deposit is generally sandy; gravel sized aggregate makes up less than 35 percent of the whole deposit. G indicates that the aggregate probably contains more than 35 percent gravel. If no information is available, the letters are omitted.

The thickness class indicates a depth range which is related to the potential resource tonnage for each deposit. Four thickness class divisions have been established as shown in the legend for Map 1.

Two smaller sets of letters, divided from each other by a horizontal line, follow the thickness class number. The upper series of letters identify the geologic deposit type (the types are summarized with respect to their main geologic and extractive characteristics in Appendix C) and the lower series of letters identify the main quality limitations that may be present in the deposit as discussed in the next section.

The other information presented on Map 1 is designed to give an indication of the present level of extractive activity in the study area. Those areas which are licenced for extraction under the Pits and Quarries Control Act (1971) are shown by a solid outline and identified by a number which refers to the pit descriptions in Table 2. Each description notes the owner, location and licenced acreage of the pit, as well as the estimated face height and particle size distribution. A number of unlicenced pits are also identified and numbered on Map 1 and described in Table 2.

Map 2 Selected Sand and Gravel Resource Areas

Map 2 is an interpretive map derived from an evaluation of the deposits shown on Map 1. The deposits identified on Map 2 are those which are considered to be important in ensuring an adequate resource base for the future.

All the Sand and Gravel Resource Areas are first delineated by geological boundaries and then classified into three levels of significance: primary, secondary and tertiary. These areas are identified on Map 2 by different shading patterns and listed on Table 3.

Each area of primary significance is assessed as to its probable relative value as a resource in the municipality and is given a deposit number which denotes its ranking order. All such deposits are shown by a medium-grey tone on Map 2.

A Selected Aggregate Resource Area of primary significance is not a permanent single-use land unit which must be incorporated in an official planning document. It represents an area in which a major aggregate resource is known to exist. Such a resource area may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

Deposits of secondary significance are not ranked numerically in this report but are indicated by a light-grey tone on Map 2. Such deposits are believed to contain significant amounts of sand and gravel for local use and in many cases provide sites for temporary wayside pits operated by or for the Ontario Ministry of Transportation and Communications and local authorities. Although deposits of secondary significance are not considered to be the best resource areas in a municipality, they may contain large quantities of sand and gravel and should be considered an integral component of the townships aggregate supply.

Areas of tertiary significance are indicated on the map by a dashed line but have no grey tone. They are neither rated nor considered to be important resource areas because of their low available resources, or because of possible difficulties in extraction. Such areas may be useful for local needs but are unlikely to support large-scale development.

The process by which deposits are evaluated and selected involves the consideration of two sets of criteria. The main selection criteria are site specific, related to the characteristics of individual deposits. Factors such as deposit size, aggregate quality, and deposit location and setting are considered in the selection of those deposits best suited for extractive development. A second set of criteria involves the assessment of local aggregate resources in relation to the quality, quantity and distribution of resources in the region in which the municipality is located. The intent of such a process of evaluation is to ensure the continuing availability of sufficient resources to meet possible future demands.

SITE SPECIFIC CRITERIA

Deposit Size

Ideally, selected deposits should contain available sand and gravel resources large enough to support a commercial pit operation using a stationary or portable processing plant. In practice, much smaller deposits may be of significant value depending on the overall reserves in the rest of the municipality. Generally, deposits in Class 1, i.e. those thicker than 20 feet (6m) and containing more than 35 percent crushable gravel are considered to be most favourable for commercial development. Thinner deposits may be valuable in municipalities with low total resources.

Aggregate Quality

The limitations of natural aggregates for various uses result from variations in the lithology of the particles comprising the deposit, and from variations in the size distribution of these particles.

Four indicators of the quality of aggregate may be included in the symbol for each deposit on Map 1. They are: gravel content (G or S), fines (C), oversize (O) and lithology (L).

Three of the indicators deal with grain size distribution. The gravel content, (G or S) indicates the suitability of aggregate for various uses. Deposits containing more than 35 percent crushable gravel are considered to be favourable extractive sites since this content is the minimum from which crushed products can be produced economically.

Excess fines or high silt and clay content may severely limit the potential use of an aggregate. Fines contents in excess of 10 percent may impede drainage in road sub-base aggregate and render it more susceptible to the effects of frost action. In asphalt aggregate, excess fines hinder the bonding of particles. Deposits known to have a high fines content are indicated by a C in the quality portion of the Deposit Symbol.

Deposits containing more than 20 percent "oversize" particles (those greater than 4 inches (10 cm) in diameter) may have use limitations. The oversize component is unacceptable for all concrete aggregate and for road building aggregate, so must be either crushed or removed during processing. Deposits known to have an appreciable oversize component are indicated by an "O" in the quality portion of the Deposit Symbol.

"Lithology" is the other indicator of the quality of an aggregate. Just as the unique physical and chemical properties of bedrock formations determine their value for use as crushed rock, so various lithologies of particles in a sand and gravel deposit determine its suitability for various uses. The presence of objectionable lithologies such as chert, siltstone and shale, even in relatively small amounts, can result in a reduction in the quality of an aggregate, especially for high quality uses. Deposits known to contain objectionable lithologies are indicated by an "L" in the quality component of the Deposit Symbol.

If the Deposit Symbol indicates either C,O, or L or any combination, the quality of the deposit is considered to be reduced for some uses of the aggregate. No attempt has been made to quantify the degree of limitation imposed. Assessment of the four indicators is made from published data, from data contained in files of the Ontario Ministry of Transportation and Communications and the Engineering and Terrain Geology Section of the Ontario Geological Survey, and from field observations. The Pavement Design and Management Section of the Ontario Ministry of Transportation and Communications has recently compiled a detailed assessment of aggregate suitability for selected areas in southern Ontario. This material has been consulted extensively in preparation of the inventory reports.

Location and Setting

The location and setting of resource area has a direct influence on its value for possible extraction. The evaluation of a deposit's setting is made on the basis of those natural and man-made features which may limit or prohibit extractive development.

First, the physical context of the deposit is considered. Deposits with some physical constraint on extractive development, such as thick overburden or high water table, are less valuable resource areas due to the difficulties involved in resource recovery. Second, permanent man-made features, such as roads, railways, powerlines and housing development, which are built on a deposit, may prohibit its extraction. The constraining effect of legally required setbacks surrounding such features is included in the evaluation. A quantitative assessment of these constraints can be made by measurement of their areal extent directly from the topographic maps. The percentage of total resources rendered unavailable by these features is shown for each resource area in Table 3.

The assessment of sand and gravel deposits and bedrock resource areas with respect to local land use and to private land ownership is an important component of the general evaluation process. These aspects of the evaluation process are not considered further in this report but readers are encouraged to discuss them with personnel of the District Office of the Ontario Ministry of Natural Resources.

REGIONAL CONSIDERATIONS

In selecting sufficient areas for resource development it is important to assess both the local and the regional resource base, and to forecast future production and demand patterns.

Some appreciation of future aggregate requirements in an area may be gained by assessing its present production levels and by forecasting future production trends. Such an approach is based on the assumptions that production levels in an area closely reflect the demand and that the present production market share of an area will remain at roughly the same level.

The aggregate resources in the region surround-

ing a municipality or township should be assessed in order to properly evaluate specific resource areas and to adopt optimum resource management plans. For example, a municipality that has large resources in comparison to its surrounding region constitutes a regionally significant resource area. Municipalities with high resources in proximity to large demand centres, such as metropolitan areas, are special cases.

Although an appreciation of the regional context is required to develop comprehensive resource management techniques (Jewett 1977, p.3), such detailed evaluation is beyond the scope of this report. The selection of resource areas made in this study is based primarily on geological data or on considerations outlined in preceding sections.

Map 3 Bedrock Resources

Map 3 is an interpretive map derived from bedrock geology, bedrock topography, drift thickness maps and from water well data from the Ontario Ministry of the Environment. It is based on concepts similar to those outlined for Maps 1 and 2, but displays both the inventory and evaluation on one map.

The geological boundaries of the labelled bedrock units are shown by a dashed line. Isolated outcrops are indicated by an "X". Three sets of contour lines delineate areas of less than 3 feet (1 m) of drift, areas of 3 to 25 feet (1 to 8 m) of drift and areas of 25 to 50 feet (8 to 15 m) of drift. The extent of the areas of thin drift is shown by three tones and is listed in Table 4. The darkest tone indicates areas where bedrock outcrops or is within 3 feet (1 m) of the ground surface. These areas constitute potential resource areas of primary significance due to their easy access. The medium tone indicates areas where drift cover is up to 25 feet (8 m) thick. Quarrying is possible in this depth of overburden and these also represent potential resource areas. The lightest tone indicates bedrock areas overlain by 25 to 50 feet (8 to 15 m) of overburden. These constitute resource areas which have extractive value only in specific circumstances. Outside of these delineated areas the bedrock can be assumed to be covered by more than 50 feet (15 m) of overburden, a depth generally considered to be too great to allow economic extraction (unless part of the overburden is composed of economically attractive sand and gravel deposits).

Other inventory information presented on Map 3 is designed to give an indication of the present level of extractive activity in the municipality. Those areas which are licenced for extraction under the Ontario Pits and Quarries Control Act (1971) are shown by a solid outline and identified by a number which refers to the quarry descriptions in Table 5. Each description notes the owner, location and licenced acreage of the quarry and an estimate of face height. Unlicenced quarries are also identified and numbered on Map 3 and described in Table 5. One additional symbol appears on the map: an open dot indicates the location of a selected water well which penetrates bedrock. The overburden thickness is shown in feet to the right of the open dot.

SELECTION CRITERIA

Criteria equivalent to those used for sand and gravel deposits are used to select bedrock areas most favourable for extractive development.

The evaluation of bedrock resources is made primarily on the basis of performance and suitability data established by laboratory testing at the Ontario Ministry of Transportation and Communications. The main characteristics and uses of the bedrock formations found in southern Ontario are summarized in Appendix D.

Deposit "size" is related directly to the areal extent of thin drift cover overlying favourable bedrock formations of sufficient thickness to support quarry operations. Since vertical and lateral variations in bedrock units are much more gradual than in sand and gravel deposits, the quality and quantity of the resource is usually consistent over large areas.

Quality of the aggregate derived from specific bedrock units is established by the performance standards previously mentioned. Location, setting criteria and regional considerations are identical to those for sand and gravel deposits.

SELECTED RESOURCE AREAS

Selection of bedrock resource areas has been restricted to a single level of significance. Three factors support this approach. Quality and quantity variations are gradual. The areal extent of a given quarry operation is much smaller than that of a sand and gravel pit producing an equivalent tonnage of material. Since crushed

bedrock has a higher unit value than sand and gravel, longer haul distances can be considered. These factors allow the identification of alternative sites having similar development potential. The wider range of possible resource areas allows greater flexibility in locating quarry operations away from areas of intensive land use competition. The Selected Areas are shown on Map 3 by a line pattern and the calculated available tonnages are given in Table 4.

It is important to realize that Selected Bedrock Resource Areas shown on Map 3 are not permanent single-use land units which must be incorporated in an official planning document. Each represents an area under which a major bedrock resource is known to exist. Such a resource area may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

PART III - ASSESSMENT OF AGGREGATE RESOURCES IN MONO TOWNSHIP

Location and Population

Mono Township occupies a roughly rectangular area of 69,804 acres (28,250 ha) in the southeast portion of Dufferin County, in southern Ontario. Portions of the township are shown on the Dundalk, Orangeville, Alliston and Bolton map sheets of the Natural Topographic System, at a scale of 1:50,000.

The Town of Orangeville is the regional trade and retail centre for the area and is partially contained in the southwest corner of the township. The 1977 population of Orangeville was 11,950 (Ontario Ministry of Treasury, Economics and Intergovernmental Affairs 1977) and figures from recent years indicate that the town is experiencing growth of nearly 5 percent per year. Indications are that such development is likely to continue in the near future. As a result, demand for mineral aggregates for use in road and residential construction is likely to increase.

Population figures for the rest of the township also show a steady and significant rate of increase. The 1977 non-urban population was 3795 and represents an increase of 25 percent over the 1975 population (Ontario Ministry of Treasury, Economics and Intergovernmental Affairs 1974,1977). Although a large proportion of the residents are engaged in farming their numbers have remained relatively constant during this period. Most of the increase has come from a rise in the number of rural-residential and other non-farm rural residents. This trend is also likely to continue in the near future. In addition to increasing the consumption of mineral aggregates, rural-residential development poses an increasingly severe constraint on extractive land use, often sterilizing potential mineral aggregate resource areas.

Physiography and Surficial Geology

The physiography of the township is controlled by the nature of the bedrock surface. The Niagara Escarpment is the dominant physiographic feature in the region. It is a cuesta scarp, produced by erosive agents eroding the bedrock surface for millions of years. It divides the township into two physiographic units: an upper, thinly drift-covered plain to the west and a lower, thickly drift-covered plain to the east. The form and distribution of unconsolidated sediments in both these areas are the result of glacial and glaciofluvial activity during part of the Great Ice Age between 7000 and 85,000 years ago (Dreimanis 1977, p.71-72).

It is thought that most of the Province was covered by a glacial advance approximately 18,000 years ago. A till unit named Catfish Creek Till (Cowan 1976) was deposited at this time. This very compact stoney till is now completely covered by younger deposits in Mono Township. The ice margin retreated from the area, then made a major readvance approximately 15,000 years ago. This advance deposited a till which forms a thin, rolling, drumlinized till plain over much of the western portion of the township. It is a silt to clayey silt till with low stone content and forms the parent material for several soil series. It has little value as a mineral aggregate resource.

Melting and retreat of the ice margin led to the deposition of vast amounts of sand and gravel. These deposits form a large ridge known as the Orangeville Moraine. The main mass of the moraine, found in the Orangeville map area (Cowan 1976) south of Mono Township, trends northward into the western half of Mono Township parallel to and just east of Highway 10. Here it is a broad irregular ridge rising 75 to 125 feet (23 to 38 m) above the till plain upon which it is built. Two spurs of the ridge are found in the northern portion of the area (Gwyn 1975). The sediments in this portion of the moraine are predominantly stratified pebbly sand with scattered gravel overlying finer grained material. A few pits have been opened in the past and one pit is presently licenced. However, this portion of the deposit has limited value as an aggregate source. To the south, near Orangeville, the aggregate is somewhat coarser, consisting of stratified pebbly sand and some gravel. Several pits have been opened and moderate resources of fair quality aggregate are still available for extraction.

Retreat of the ice margin southeastward from the Orangeville Moraine, down to the base of the

Escarpment, led to the development of an extensive meltwater channel system carrying sediment-laden water south between the Escarpment and the ice margin. Extensive outwash terrace gravel was deposited at this time forming what has been named the Lavender-Violet Hill Meltwater Channel (Gwyn 1975). Two terraces are present at Violet Hill: one at 1425 feet (435 m) above sea level (a.s.l.) and a lower terrace at 1350 feet (412 m) a.s.l. The upper terrace consists of 10 to 13 feet (3 to 4 m) of pebbly gravel overlying silty, pebbly, medium sand. This material has been extracted at several places and constitutes an important local resource. The lower terrace is similar but exposures are not as good.

The ice at the Niagara Escarpment then retreated and later readvanced to the same location, depositing till in parts of eastern Mono Township and building the Singhampton-Gibraltar Moraine just east of the meltwater channel. This moraine ridge is up to 2.5 miles (4 km) wide and has a broad, flat crest 50 to 150 feet (15 to 46 m) above the surrounding terrain. Most exposures in the moraine show pebbly to bouldery, medium sand, containing small amounts of crushable aggregate. Only two small pits have been opened in the moraine. The materials in the moraine are generally poor quality because of the low gravel content and great textural variability of the aggregate.

Meltwaters from the melting ice margin flowed southwestward depositing extensive amounts of outwash gravel at the head of the Hockley Valley on the brow of the Escarpment. The Hockley Valley Outwash (Cowan 1976) constitutes an important, and as yet little used, aggregate resource.

The last readvance in the area came again from the northeast but did not reach the Escarpment. Vast amounts of the fine-grained sediments were carried westward from the ice margin and deposited in an extensive outwash plain between the ice margin and the Escarpment, in the east-central portion of the township. These deposits consist of a surface unit of silty, medium sand 6 to 30 feet (2 to 9 m) thick which overlies interbedded sand, gravel, till, and silt.

After the final retreat of glacial ice from the area, Sheldon Creek, the Nottawasaga River, and their tributaries began incising deep channels into the outwash plain. Three terrace levels were produced: at approximately 1075 feet (328 m) a.s.l., at 975 feet (297 m) a.s.l., and at 925 feet (282 m) a.s.l. The sediments in these terraces were derived from the outwash plain and closely reflect its composition. Texturally, the aggregate is better sorted and coarser than the outwash plain, but the gravel content is still low. Postglacial activity in the area has been restricted to fluvial erosion, deposition of alluvium, and to limited eolian activity on the outwash plain.

Extractive Activity

More than thirty sand and gravel pits have been opened in Mono Township, eleven of which are presently licenced to operate under terms of the Pits and Quarries Control Act (1971). Licenced properties in the township occupy 795 acres (322 ha) (see Table 2). Resource calculations have been made for these areas and total available sand and gravel resources on presently licenced properties are estimated to be 24 million tons (22 million tonnes).

Total production figures from licenced sources are compiled annually by the Mineral Resources Branch and District Offices of the Ontario Ministry of Natural Resources. The average annual production over the last five years in Mono Township has been approximately 0.8 million tons (0.7 million tonnes). In addition, average annual production from wayside pits, for which permits are required, is estimated to be approximately 100,000 tons (90,000 tonnes). These figures are tabulated by the District Offices of the Ontario Ministry of Natural Resources. The total average annual production from all sources in the township is approximately 0.9 million tons (0.8 million tonnes).

Selected Sand and Gravel Resources

Map 1 shows the widespread occurrence of sand and gravel in Mono Township. The total area occupied by these materials is 53,522 acres (21,660 ha) which represents more than 75 percent of the total land area of the township. These deposits contain total possible resources of approximately 3014 million tons (2734 million tonnes). It should be noted, however, that the above figures represent a comprehensive

inventory of all granular materials in the township and do not represent an assessment of Mono Township's viable resource base under present economic and technological conditions. Much of the material included in the estimate has low potential for use now and in the forseeable future. As shown in Table 1, resources in deposits containing appreciable amounts of crushable material may total only 320 million tons (290 million tonnes). This is a better estimate of the township's "usable" resource base. Of these resources, specific deposits have been selected and shown on Map 2. They are indicated by a dark tone and numbered sequentially in order of their value as resources. The deposits of secondary importance are shown by a lighter tone on Map 2 but are not ranked numerically. Such deposits may not be commercially valuable but may have local strategic value. The Selected Resource Areas comprise a total area of 3685 acres (1491 ha) and represent 7 percent of the total extent of all deposits in the township. The total available sand and gravel resources in these deposits are estimated to be 182 million tons (165 million tonnes), which is approximately 6 percent of the township's total aggregate resource tonnage.

The Selected Resource Areas generally correspond to areas identified in an earlier study of the aggregate resources of Mono Township (Cowan and Gwyn 1976).

SELECTED SAND AND GRAVEL RESOURCE AREA 1

The most important aggregate source in the township is the Hockley Valley Outwash terrace, just north of Orangeville, at the head of the Hockley Valley. These gravels are medium-to coarse-textured and stone content generally ranges from 40 to 60 percent. Observed thicknesses do not exceed 20 feet (6 m), however, water well and boring data indicate thickness in excess of 100 feet (30 m). Material occuring at greater depth is probably not of as good quality as the uppermost 30 feet (9 m) (Cowan 1976, p.60). Siltstone and shale derived from the Georgian Bay and Queenston Formations are common constituents of the gravel in these deposits. Since they are soft and not resistant to abrasion, these rock types are unsuitable for production of crushed products. Much of the southwestern portion of the Hockley Valley Outwash is unavailable for extraction due to suburban development.

Resource Area 1 is located on the north shore of the Orangeville Reservoir and has an area of 591 acres (239 ha). The land surface in the area is generally smooth and level, except along its extensively dissected northern edge which forms part of the Hockley Valley. Ice-contact sand deposits are exposed on the lower slopes of the valley in this vicinity. Similar ice-contact material may underlie most of Area 1 at depths of 20 to 40 feet (6 to 12 m). Possible resources in Area 1 are estimated to be 34 million tons (31 million tonnes) based on an assumed average thickness of 23 feet (7 m). Approximately 17 percent of the aggregate is unavailable due to various physical and cultural constraints, leaving 28 million tons (25 million tonnes) presently available for extraction.

Three pits have been worked along the western edge of the terrace. One pit, at Location 5, is presently licenced although no extraction was taking place when the area was field checked. Pit faces range in height from 20 to 40 feet (6 to 12 m) and expose moderately sorted and stratified sand and gravel with a 40 to 45 percent stone content. Some water well data in the area indicated 70 to 100 feet (21 to 30 m) of granular material. This estimate probably includes the poorer quality underlying ice-contact material. The coarse aggregate from the deposit is generally acceptable for granular base course. Location 5 is one of only two pits in the township capable of supplying acceptable H.L.4 (Appendix C) aggregate (Deike 1977).

The outwash in Area 1 forms the parent material for soils which are generally well suited for agriculture but may be droughty and susceptible to erosion (Hoffman *et al.* 1964). Most of the deposit is cleared and presently under cultivation. The lower slopes of the terrace to the north and south of Area 1 are hazardous lands. Further examination of these areas may be required to assess their suitability for extraction.

SELECTED SAND AND GRAVEL RESOURCE AREA 2

Selected Resource Area 2 is part of the Mono Mills Meltwater Channel (White 1975). The west bank of the channel was formed by the Escarpment, while the east bank, now almost entirely absent, was probably formed by the margin of the glacier itself. The deposit was thus formed as an ice-contact terrace (see Appendix C). The stratigraphy of the deposit is generally

characterized by an upper sandy unit 2 to 16 feet (1 to 5 m) thick, overlying coarser material which is exposed in the pits and along the valley of the Humber River. The deposit, excluding licenced areas, covers 647 acres (262 ha) and has possible sand and gravel resources of 28 million tons (25 million tons), approximately 17 percent of which may be unavailable for extraction due to physical and cultural constraints. The northern extension of this deposit, shown as possible resources by Cowan and Gwyn (1976), has been classified accordingly as being of tertiary significance. The land surface is flat and, except at the dissected terrace margins, presents no difficulties for extraction. Two licenced sites, with a total licenced acreage of 402 acres (163 ha), occupy much of the southern portion of the deposit. Faces in the pits range in height from 15 to 25 feet (5 to 8 m) and expose an upper unit of medium to coarse sand overlying moderately sorted and stratified gravel and sand. Stone content is variable but is in the range of 40 to 50 percent in the lower unit. The quality limitations of the aggregate in Resource Area 2 are much the same as those of other outwash deposits. Selection and sand control are required for crushing. Stone quality is poor, due to siltstone content. The fine fraction is coarse and dirty for asphaltic products (Deike 1977).

SELECTED SAND AND GRAVEL REOSURCE AREA 3

Selected Resource Area 3 comprises 616 acres (249 ha) on the upper terrace of the Lavender-Violet Hill Meltwater Channel at the northern boundary of the township. The land surface is smooth and level, but is deeply dissected in several places by tributary streams of Sheldon Creek. These sloping areas may present problems for extractive development and may reduce the amount of material available for extraction.

Two pits have been opened in this deposit in Mono Township. They are quite small and may have been operated for local use. One pit is presently licenced and has an area of 16 acres (6 ha). A 15 foot (5 m) face exposes moderately sorted and stratified sand and medium gravel which is 35 to 45 percent stone. Ontario Ministry of Transportation and Communications (M.T.C.) data for Area 3 indicates that gravel content ranges from 25 to 55 percent. This fraction is suitable for most crushed products, although siltstone is a common constituent of the aggregate and may limit higher quality uses. The fine aggregate is generally unsuitable for asphaltic mixes due to the siltstone content and to a high content of silt-and clay-sized particles. Pits in the deposit have been given a low to moderate rating for material suitability by the M.T.C. (Deike 1977). Total available resources in Resource Area 3 are estimated to be 27 million tons (24 million tonnes). The land in the Area is cleared and is presently under cultivation. The deposit directly overlies and obscures part of the Niagara Escarpment and so may be constrained for extractive development. Telford and Narain (1976, p.31) have defined most of the Lavender-Violet Hill Meltwater Channel as a high priority resource area.

SELECTED SAND AND GRAVEL RESOURCE AREA 4

Selected Resource Area 4 is a portion of the Hockley Valley Outwash on the north side of the Hockley Valley. The total area is 1422 acres (576 ha). Extraction may not be feasible in the vicinity of the steeply sloping, dissected topography on the southern edge of the terrace. The general stratigraphy in Area 4 is similar to that of Area 1; 20 to 40 feet (6 to 12 m) of outwash gravel overlying generally sandier, ice-contact stratified drift. No pits have been operated in the Area and no testing has been done by the M.T.C. so that estimates of the aggregate's texture and quality can only be made on the basis of comparisons with other portions of the deposit complex. Assuming an average thickness of 30 feet (9 m), possible resources in Area 4 are estimated to be 106 million tons (96 million tonnes) of which 90 million tons (82 million tonnes) may be presently available for extraction. Soils and land use are the same as for Resource Area 1. Nearly all of the deposit is cleared and under cultivation.

SELECTED SAND AND GRAVEL RESOURCE AREA 5

Selected Resource Area 5 is a portion of the Orangeville Moraine just north of the Town of Orangeville. The Area is characterized by rolling to hummocky topography. Water well data indicate thickness of granular material from 50 to 150 feet (15 to 46 m) with sandy material near the surface. Stone content ranges from 10 to 60 percent and is variable laterally, except in areas of predominantly glaciofluvial deposition.

At least four pits have been opened in the past; only one is presently licenced to operate. The Lockyer Brothers pit (Location 6) has a 25 foot (8 m) north face consisting of 2 feet (1 m) of gravel overlying 18 feet (6 m) of well sorted and stratified sandy gravel and pebbly, fine to coarse sand. Siltstone and shale content ranges from 5 to 10 percent, being generally higher in the moraine than in associated outwash deposits. Consequently, petrographic numbers are high (160 to 250, Cowan 1976) and beneficiation is required for high specification products. Resource Area 5 was delineated on the basis of its topographic difference from the rest of the moraine, and due to the fact that all local pit development has been in this area. The measured acreage of the deposit is 384 acres (155 ha) and possible resources are estimated to be 14 million tons (13 million tonnes) on the basis of being an assumed deposit thickness of 15 feet (5 m). Approximately 13 percent of the material is affected by physical constraints leaving 12 million tons (11 million tonnes) presently available for extraction.

SELECTED SAND AND GRAVEL RESOURCE AREA 6

Selected Resource Area 6 is a small esker segment a few miles west of Mono Centre. Although it is quite small in terms of resource tonnage, it is the best source of high quality aggregate in the township (Deike 1977). A licenced pit owned by Greenwood Construction occupies the entire northern end of the deposit. A 12 foot (4 m) face in the pit exposes interbedded, moderately sorted gravel (60-70 percent) and coarse, pebbly sand. An asphalt plant is located on the property to produce bituminous road-surfacing materials. The southern portion of the esker is 25 acres (10 ha) in extent and contains estimated resources of 2 million tons (2 million tonnes). Care should be taken to ensure the continuing availability of this high quality material because of its scarcity elsewhere in the township.

SAND AND GRAVEL RESOURCE AREAS OF SECONDARY SIGNIFICANCE

Seven Sand and Gravel Resource Areas of Secondary Significance have been identified in Mono Township and are shown by a light tone on Map 2. The lower terrace of the Lavender-Violet Hill Meltwater Channel, adjacent to Selected Sand and Gravel Resource Area 3, may have resources of sandy aggregate suitable for sand cushion and fill. A similar terrace extending south from Area 3 to Mono Centre contains higher proportions of crushable gravel and a greater depth of material. Both these Areas were shown as probable resources by Cowan and Gwyn (1976) and could supply large quantities of aggregate. They are classified here as Secondary Resources due to operational difficulties imposed by topography, height of water table and deposit geometry. These are similar to, but more severe than, those discussed for Selected Sand and Gravel Resource Area 3. Two other Areas, east of Hockley Valley, are outwash terraces along the Nottawasaga River. These are the western extensions of Areas selected for possible resource protection in Adjala Township and may contain large resources of aggregate suitable for low-specification uses. A fifth Area, northeast of Purple Hill, is similar in size and character to Selected Sand and Gravel Resource Area 1. The two remaining Resource Areas of Secondary Significance are north of Orangeville along Highway 24. As part of the important Hockley Valley Outwash complex, these three deposits may warrant greater consideration than the possible category, initially indicated by Cowan and Gwyn (1976). Until further information is available they should be considered as resources of secondary significance.

Bedrock Geology

The township is underlain by Ordovician shales to the east of the Niagara Escarpment. The rest of the area is underlain by Silurian shales, limestones, and dolostones, which form the face and brow of the Niagara Escarpment. The units are essentially flat-lying, with a gentle regional dip to the southwest. The distribution of these units is shown on Map 3 (after Telford *et al.* 1975 a,b,c). The names, lithologies, and stratigraphic relationships of the units are summarized in the legend on Map 3. Areas of bedrock covered by 0 to 3 feet (0 to 1 m), 3 to 25 feet (1 to 8 m) and 25 to 50 feet (8 to 15 m) of drift are also outlined on the map.

Brown and black shales of the Georgian Bay Formation (Hewitt 1972, p.7) underlie a small area along the western boundary of Mono Township from Hockley to Sheldon Hill. Material from this unit has been extracted near Toronto for brick manufacture and for pro-

duction of heat-expanded aggregate, but the drift cover in the area is too great to permit quarrying.

The Georgian Bay Formation is overlain by red and green shales of the Queenston Formation which occur in subcrop throughout the eastern half of the township, and form the basal unit of the Niagara Escarpment. The Queenston Formation is an important regional source of raw material for the brick industry and has been extensively developed for that use near Toronto. There are two areas of outcrop and thin drift cover in the northeast and southeast corners of the township. Both may be well suited for quarry development. In addition, there are several small areas of outcrop along the northern side of the Hockley Valley. Although the Queenston Formation has significant industrial value, it is not suitable for crushed products for road building or for construction.

The Queenston Formation is overlain by a succession of Silurian units which form the face of the Escarpment. Formations of the Cataract Group underlie the lower, mantled portion of the main scarp face. Some of the units, namely the Whirlpool and Manitoulin Formations, have been extracted in several quarries to the south (Hewitt 1972, p.9) for building stone and road aggregate respectively. Exposures of both units are restricted to the scarp face and are unlikely candidates for extractive development in Mono Township.

Overlying the Manitoulin Formation are shales and dolostones of the Cabot Head and Fossil Hill Formations. Exposures of these units are poor and are also restricted to the scarp face. The soft, easily weathered nature of the formations makes them generally unsuitable for aggregate.

The Amabel Formation forms the exposed, upper face of the Escarpment and underlies the entire western portion of Mono Township. It consists of white, massive, fine crystalline dolostone. Reef structures, characterized by fine crystallinity and higher density, are common throughout the unit. The crushed product is generally sound, resistant to abrasion, and resistant to chemcial weathering processes. It is suitable for use both as road-building and construction aggregate and constitutes a regionally important aggregate resource. Several areas in the central portion of the township are thinly drift covered and may be suitable for extractive development.

The Guelph Formation overlies the Amabel dolostone and occurs under relatively thin drift in the extreme northwest corner of Mono Township. It consists of fine, crystalline, tan dolostone and has been extracted near Shelburne for the manufacture of lime. The Guelph Formation is not usually suitable for producing crushed products because it is not resistant.

Although the above formations have been quarried elsewhere in the Province, no quarries have been established in Mono Township. Several areas, particularly those overlying rocks of the Queenston and Amabel Formations, may be suitable for extraction. These are outlined below and in Table 6.

Selected Bedrock Resources

AMABEL FORMATION

The Amabel Formation constitutes an aggregate source of Province-wide significance. It is important that as much of the available resources as possible be protected for future use.

Most areas of outcrop or thin drift cover are restricted to the face and brow of the Escarpment. These areas are all within the Niagara Escarpment Planning Area, and have been identified as high priority resource areas by Telford and Narain (1975). There are two areas of outcrop and thin drift cover on the main scarp face which have been selected for possible resource protection.

Selected Bedrock Resource Areas 1 and 2

Resource Area 1 is a portion of the main Niagara Escarpment face extending north from Mono Centre. Drift cover is thin throughout the Area and surface exposures are common. The Resource Area covers 522 acres (211 ha), and assuming an average thickness of 60 feet (18 m) has resources of 113 million tons (102 million tonnes), of which 104 million tons (94 million tonnes) may be presently available for extraction.

Resource Area 2 also lies along the brow of the Escarpment just south of the hamlet of Mono Centre. It comprises 292 acres (118 ha)

and has available resources estimated to be 56 million tons (51 million tonnes).

Both Areas are located entirely within the Niagara Escarpment Planning Area, and may not be available for extraction.

Selected Bedrock Resource Areas 3 and 4

Selected Resource Areas 3 and 4 are in the southeast corner of Mono Township. Both are small areas of thin drift cover surrounding small surface exposures. In Area 3 the face of the Escarpment is exposed for a considerable distance. Total acreage of both Resource Areas is 260 acres (105 ha) and total available resources are estimated to be 52 million tons (47 million tonnes). The bedrock is overlain primarily by sandy silt till which poses relatively few extraction problems, although it may be underlain by a basal unit of hard till lying directly on the bedrock. In areas of thin drift the soils have generally low potential for agriculture. Road access to the area is good.

Summary

In summary, except for the main face of the Escarpment, the Selected Bedrock Resource Areas are small but may provide acceptable sites for small-scale development. Further investigation is required in all four Areas.

QUEENSTON FORMATION

Selected Bedrock Resource Areas 5 and 6

Although the Queenston Formation is not suitable for crushed-stone products, it is an important resource for brick and tile manufacture. Selected Bedrock Resource Areas 5 and 6 are located in the southeast corner of the township where there is thin drift cover over the Queenston shale. Small isolated areas of outcrop are found just north and south of the hamlet of Lucille. Water well data indicate that drift thickness throughout the Areas may be generally less than 30 feet (9 m). Overburden consists mainly of ice-contact stratified drift upon which are developed coarse, sandy soils. The Areas are characterized by hilly topography with short, relatively steep slopes. The topography, as well as susceptibility of the soil to erosion, make the Areas generally unsuitable for crop cultivation. Unimproved pasturage is the main agricultural use. Resource Area 5 comprises 391 acres (158 ha) and , assuming an average quarriable thickness of 60 feet (18 m), has available resources of 68 million tons (62 million tonnes).

Selected Bedrock Resource Area 6 forms the western extension of an area of thin drift selected for resource protection in Adjala Township. It covers 131 acres (53 ha), and has available resources of 20 million tons (18 million tonnes).

Selected Bedrock Resource Area 7

Resource Area 7 lies in the northeast corner of the township. It forms the western extension of a large area of thin drift over the Queenston Formation which has been selected for resource protection in adjoining Adjala and Mulmur Townships. Although there are no surface exposures, the topography of the area and some water wells indicate that drift cover may be generally less than 25 feet (8 m). The Area covers 1602 acres (648 ha), and has possible resources of 308 million tons (279 million tonnes). The presence of the hamlet of Rosemount, as well as several roads and farm buildings, may prohibit extraction on approximately 12 percent of Resource Area 7, leaving available resources of 271 million tons (245 million tonnes).

Summary

Generally, Mono Township has large resources of Queenston Formation bedrock. It is suitable for the manufacture of brick, tile and other clay products, but is not suitable for the production of crushed stone for road construction.

Questions regarding the Aggregate Resources Inventory of Mono Township should be directed to the Ontario Ministry of Natural Resources either at the Huronian District Office, Midhurst, Ontario, L0L 1X0, (Tel. (705) 728-2900) or at the Central Region Office, 10670 Yonge Street, Richmond Hill, Ontario, L4C 3C9 (tel. (416) 884-9203).

TABLE 1 | **TOTAL SAND AND GRAVEL RESOURCES, MONO TOWNSHIP**

THICKNESS CLASS NO.	GEOLOGICAL TYPE (see Appendix C)	AREAL EXTENT ACRES (HECTARES)	ORIGINAL TONNAGE MILLIONS OF TONS (TONNES)
1	G-OW	4630 (1874)	273 (248)
	S-OW	4546 (1840)	264 (240)
	G-IC	398 (161)	25 (23)
	S-IC	17,633 (7136)	1436 (1303)
2	G-OW	596 (241)	16 (14)
	S-OW	1293 (523)	54 (49)
	G-IC	384 (155)	14 (13)
	S-IC	17,361 (7026)	813 (738)
3	G-OW	276 (112)	5 (4)
	S-OW	1854 (750)	46 (42)
	S-IC	1697 (687)	32 (29)
4	G-OW	78 (32)	1 (1)
	S-OW	2776 (1123)	35 (32)
		53,522 (21 660)	3014 (2734)

TABLE 2 | SAND AND GRAVEL PITS, MONO TOWNSHIP

PIT NO.	MTC NO.	OWNER/OPERATOR	LOT	CON.	LICENCED AREAS ACRES (HECTARES)	FACE HEIGHT FEET (METRES)	PERCENT GRAVEL
	LICENCED PITS						
1.	B10-149	Consolidated Sand & Gravel	Pt.2, 3,4	7EHS	302.2 (122.3)	15 (5)	
2.		Kilmer van Nostrand	E½ 3	6EHS	100.0 (40.5)	12 (4)	
3.	B10-27	Doug's Haulage	10	7EHS	11.0 (4.4)	15 (5)	30
4.	O10-145	Erick M. White	Pt.E½ 6	3EHS	24.8 (10.0)	30 (9)	0-60
5.	O10-82	Harry W. Baker	Pt.5, Pt.E½ 4	1WHS	28.0 (11.3)	25 (8)	30-70
6.	O10-146	Lockyer Brothers Ltd.	W½ 3, 4	3WHS	113.0 (45.7)	15 (5)	
7.		Greenwood Construction Co. Ltd.	Pt.W½	2WHS	34.5 (14.0)	20 (6)	
8.	D4-23	Greenwood Construction Co. Ltd.	W½ 21	1WHS	84.0 (34.0)	20 (6)	
9.		Harry Donaldson	Pt.19	3EHS	10.5 (4.2)	20 (6)	
10.	D4-130	D. Doan	E½ 30	2EHS	16.0 (6.5)	15 (5)	40-60
11.		Lorne Patton	29	3WHS	71.0 (28.7)		
					795.0 (322.0)		

TABLE 2 | SAND AND GRAVEL PITS, MONO TOWNSHIP

PIT NO.	MTC NO.	OWNER/OPERATOR	LOT	CON.	LICENCED AREAS ACRES (HECTARES)	FACE HEIGHT FEET (METRES)	PERCENT GRAVEL
	UNLICENCED PITS						
12.	D4-34	M. Little	28	3W		20 (6)	
13.	D4-102	Little	26	2W			
14.	D9-00	McBride	29,30	1WHS		10 (3)	
15.	D4-94	Hodgson	30	1W		40 (12)	
16.	D4-93	(Hudasek Peatson)	32	1WHS			
17.	D4-56	Dufferin Sand and Gravel	32	2E		25 (8)	40
18.	D4-55	(Wake) H. Martin	31	4		9 (3)	55
19.	D4-128	W. Haddock	23	6			
20.	O10-99	Lennox	10	5			
21.	B10-15	Connor Sand and Gravel	3	6			
22.	O10-85	Irvine	1	6		15-25 (5-8)	
23.	O10-55	Woodland	3	2E		20 (6)	35-75
24.	O10-56	Lomas & Boyer	1	1		10 (3)	
25.	O10-1	Shirley	6	1EHS		20 (6)	40

TABLE 2 | SAND AND GRAVEL PITS, MONO TOWNSHIP

PIT NO.	MTC NO.	OWNER/OPERATOR	LOT	CON.	LICENCED AREAS ACRES (HECTARES)	FACE HEIGHT FEET (METRES)	PERCENT GRAVEL
	UNLICENCED PITS						
26.	O10-144	J.D. Dinnick	W¼ 4	2WHS		15 (5)	
27.	O10-123	Clayton Baston	5	3W	10 (4)	10-75 (3-23)	
28.	O10-124	Willie Bahr	10	1W	10 (4)		
29.	O10-125	Jackson DHO	11	1E	5 (2)	25 (8)	

TABLE 3 | SELECTED SAND AND GRAVEL RESOURCE AREAS, MONO TOWNSHIP

1	2	3	4	5	6	7	8
DEPOSIT NO.	AREA ACRES (HECTARES)	DEPTH FEET (METRES)	ORIGINAL TONNAGE MILLIONS OF TONS (TONNES)	AGGREGATE REMOVED (PERCENT OF COLUMN 4)	REMAINING TONNAGE MILLIONS OF TONS (TONNES)	AGGREGATE UNAVAILABLE (PERCENT OF COLUMN 6)	AVAILABLE TONNAGE MILLIONS OF TONS (TONNES)
1.	591 (239)	23 (7)	34 (31)	1	34 (31)	17	28 (25)
2.	647 (262)	17 (5)	28 (25)	1	28 (25)	17	23 (21)
3.	616 (249)	20 (6)	31 (28)	1	31 (28)	14	27 (24)
4.	1422 (576)	30 (9)	107 (97)	1	106 (96)	15	90 (82)
5.	384 (155)	15 (5)	14 (13)	1	14 (13)	13	12 (11)
6.	25 (10)	28 (8)	2 (2)	0	2 (2)	0	2 (2)
	3685 (1491)		216 (196)		215 (195)		182 (165)

TABLE 4 | TOTAL IDENTIFIED BEDROCK RESOURCES, MONO TOWNSHIP

DRIFT THICKNESS FEET (METRES)	FORMATION	WORKABLE THICKNESS FEET (METRES)	AREAL EXTENT ACRES (HECTARES)	ORIGINAL TONNAGE MILLIONS OF TONS (TONNES)
Outcrop	Georgian Bay	– NOT EXPOSED –		
3-25 (1-8)	Georgian Bay	60 (18)	20 (8)	4 (4)
25-50 (8-15)	Georgian Bay	60 (18)	58 (24)	11 (10)
Outcrop	Queenston	60 (18)	70 (28)	13 (12)
3-25 (1-8)	Queenston	60 (18)	3702 (1498)	711 (645)
25-50 (8-15)	Queenston	60 (18)	2816 (1140)	541 (491)
Outcrop	Manitoulin	60 (18)	108 (44)	23 (21)
3-25 (1-8)	Manitoulin	60 (18)	827 (335)	179 (162)
25-50 (8-15)	Manitoulin	60 (18)	2810 (1137)	607 (551)
Outcrop	Amabel	60 (18)	283 (114)	61 (55)
3-25 (1-8)	Amabel	60 (18)	1276 (516)	276 (250)
25-50 (8-15)	Amabel	60 (18)	6278 (2541)	1356 (1230)
Outcrop	Guelph	– NOT EXPOSED –		
3-25 (1-8)	Guelph	60 (18)	6 (2)	1 (1)
25-50 (8-15)	Guelph	60 (18)	34 (14)	7 (6)
			18,288 (7 401)	3790 (3438)

TABLE 5	QUARRIES,	MONO TOWNSHIP				
QUARRY NO.	MTC NO.	OWNER/OPERATOR	LOT	CON.	LICENCED AREA ACRES (HECTARES)	FACE HEIGHT FEET (METRES)
		NONE				

TABLE 6 | SELECTED BEDROCK RESOURCE AREAS, MONO TOWNSHIP

1	2	3	4	5	6	7	8	9
DEPOSIT NO.	AREA ACRES (HECTARES)	DEPTH OF OVERBURDEN FEET (METRES)	WORKABLE THICKNESS FEET (METRES)	ORIGINAL TONNAGE MILLIONS OF TONS (TONNES)	AGGREGATE REMOVED (PERCENT OF COLUMN 5)	REMAINING TONNAGE MILLIONS OF TONS (TONNES)	AGGREGATE UNAVAILABLE (PERCENT OF COLUMN 7)	AVAILABLE TONNAGE MILLIONS OF TONS (TONNES)
AMABEL FORMATION								
1.	522 (211)	25 (8)	60 (18)	113 (102)	0	113 (102)	8	104 (94)
2.	292 (118)	25 (8)	60 (18)	63 (57)	0	63 (57)	11	56 (51)
3.	186 (75)	25 (8)	60 (18)	40 (36)	0	40 (36)	6	38 (34)
4.	74 (30)	25 (8)	60 (18)	16 (14)	0	16 (14)	12	14 (13)
	1074 (435)			232 (210)		232 (210)		212 (192)
QUEENSTON FORMATION								
5.	391 (158)	25 (8)	60 (18)	75 (68)	0	75 (68)	9	68 (62)
6.	131 (53)	25 (8)	60 (18)	25 (23)	0	22 (23)	10	20 (18)
7.	1602 (648)	25 (8)	60 (18)	308 (279)	0	308 (279)	12	271 (245)
	2124 (860)			408 (370)		408 (370)		359 (326)

REFERENCES

Association of Professional Engineers of Ontario
1976: Performance Standards for Professional Engineers Advising on and Reporting on Oil, Gas and Mineral Properties; Association of Professional Engineers of Ontario, 11p.

Cowan, W.R.
1976: Quaternary Geology of the Orangeville Area, Southern Ontario; Ontario Division of Mines, Geological Report 141, 98p. Accompanied by maps 2326, 2327, and 2328, scale 1:50,000.

Cowan, W.R. and Gwyn, Q.H.J.
1976: Recommendations for Sand and Gravel Extractive Areas, Mono Township, Dufferin County, Southern Ontario; Ontario Division of Mines, Open File Report 5202, 6p. 2 tables, 4 maps, scale 1:50,000

Deike, W.
1977: Aggregate Suitability Evaluation, Mono Township, Dufferin County; Aggregate Unit, Pavement Design and Management Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications, unpublished report,4p.

Dreimanis, A.
1977: Late Wisconsin Glacial Retreat in the Great Lakes Region, North America; Annals of the New York Academy of Sciences, Volume 288, p.70-89.

Gwyn, Q.H.J.
1972: Quaternary Geology of the Dundalk Area, Southern Ontario; Ontario Department of Mines and Northern Affairs, Preliminary Map P.727, Geological Series, scale 1:50,000.
1975: Quaternary Geology of the Dundalk Area, Southern Ontario; Ontario Division of Mines, Open File Report 5132, 138p. 22 tables, 14 figures, 4 maps, scale 1:50,000.

Gwyn, Q.H.J. and Fraser, J.Z.
1975a: Bedrock Topography of the Dundalk Area, Southern Ontario; Ontario Division of Mines, Preliminary Map P.306 (revised), Bedrock Topography Series, scale 1:50,000.
1975b: Drift Thickness of the Dundalk Area, Southern Ontario; Ontario Division of Mines, Preliminary Map P.1023, Drift Thickness Series, scale 1:50,000.

Gwyn, Q.H.J. and White, S.
1973: Quaternary Geology of the Alliston Area, Southern Ontario; Ontario Division of Mines, Preliminary Map P.835, Geological Series, scale 1:50,000.

Hewitt, D.F.
1972: Paleozoic Geology of Southern Ontario; Ontario Division of Mines, Geological Report 105, 18p. Accompanied by Map 2254, scale 1:1,013,760.

Hoffman, D.W., Matthews, B.C. and Wicklund, R.E.
1964: Soil Survey of Dufferin County, Ontario; The Ontario Soil Survey, Report No.38, 75p.

Jewett, G.A.
1977: Aggregates, A Case History of Resource Management in Ontario, "A Challenge in Communication"; Ontario Geological Survey, Miscellaneous Paper 74, 9p. 4 charts.

Ontario Ministry of Natural Resources
1977: Ontario Mineral Review 1976-77; Ontario Ministry of Natural Resources, 95p.

Ontario Ministry of Treasury, Economics and Intergovernmental Affairs
1974: Municipal Directory, 1974; Queen's Printer, 128p.
1977: Municipal Directory, 1977-78; Queen's Printer, 177p.

Robertson, J.A.
1975: Mineral Deposit Studies, Mineral Potential Evaluation and Regional Planning in Ontario; Ontario Division of Mines, Miscellaneous Paper 61, 42p.

Telford, P.G., Bond, I.J., and Liberty, B.A.
1975a: Paleozoic Geology of the Bolton Area, Southern Ontario; Ontario Division of Mines, Map 2338, scale 1:50,000.
1975b: Paleozoic Geology of the Orangeville Area, Southern Ontario; Ontario Divi-

sion of Mines, Map 2329, scale 1:50,000.

1975c: Paleozoic Geology of the Dundalk Area, Southern Ontario; Ontario Division of Mines, Map 2340, scale 1:50,000.

Telford, P.G. and Narain, M.

1976: Industrial Mineral Resources Inventory of the Niagara Escarpment Planning Area; Ontario Ministry of Natural Resources, unpublished report, 97p.

White, O.L.

1975: Quaternary Geology of the Bolton Area, Southern Ontario; Ontario Division of Mines, Geological Report 117, 119p. Accompanied by maps 2275 and 2276, scale 1:63,360.

APPENDIX A-GENERAL READING

American Geological Institute
1962: Glossary of Geology and Related Sciences National Academy of Sciences, National Research Council, Washington, D.C., 325p.

Bauer, A.M.
1970: A Guide to Site Development and Rehabilitation of Pits and Quarries; Ontario Department of Mines and Northern Affairs, Industrial Mineral Report 33, 62p

Cowan, W.R.
1977: Towards the Inventory of Ontario's Mineral Aggregates; Ontario Geological Survey, Miscellaneous Paper 73, 19p.

Fairbridge, R.W. (ed.)
1968: The Encyclopedia of Geomorphology; Encyclopedia of Earth Sciences, Vol.III, Reinhold Book Corp., N.Y., 1295p.

Fint, R.F.
1971: Glacial and Quaternary Geology; John Wiley and Sons Inc., 892p.

Guillet, G.R.
1967: The Clay Products Industry of Ontario; Ontario Department of Mines, Industrial Mineral Report 22, 206p.

Hewitt, D.F.
1960: The Limestone Industries of Ontario; Ontario Department of Mines and Northern Affairs, Industrial Mineral Report 5, 177p.
1964a: Building Stones of Ontario, Part I Introduction; Ontario Department of Mines Industrial Mineral Report 14, 43p.
1964b: Building Stones of Ontario, Part II Limestone, Ontario Department of Mines, Industrial Mineral Report 15, 41p.
1964c: Building Stones of Ontario, Part III Marble; Ontario Department of Mines, Industrial Mineral Report 16, 89p.
1964d: Building Stones of Ontario, Part IV Sandstone; Ontario Department of Mines, Industrial Mineral Report 17, 56p.
1972: Paleozoic Geology of Southern Ontario; Ontario Division of Mines, Geological Report 105, 18p.

Hewitt, D.F. and Karrow, P.F.
1963: Sand and Gravel in Southern Ontario; Ontario Department of Mines Industrial Mineral Report 11, 150p.

Hewitt, D.F. and Vos, M.A.
1970: Urbanization and Rehabilitation of Pits and Quarries; Ontario Department of Mines, Industrial Mineral Report 34, 21p.

Ontario Ministry of Natural Resources
1975: Vegetation for the Rehabilitation of Pits and Quarries; Forest Management Branch, Division of Forests, 38p.
1977: A Policy for Mineral Aggregate Resource Management in Ontario; Report of the Ontario Mineral Aggregate Working Party, 232 p.

Proctor and Redfern Ltd.
1974: Mineral Aggregate Study, Central Ontario Planning Region; Prepared for the Ontario Ministry of Natural Resources.

Proctor and Redfern Ltd., and
Gartner Lee Associates Ltd.
1975: Mineral Aggregate Study and Geological Inventory, Part of the Eastern Ontario Region; Prepared for the Ontario Ministry of Natural Resources.
1977: Mineral Aggregate Study and Geological Inventory, Southwestern Region of Ontario; Prepared for the Ontario Ministry of Natural Resources.

APPENDIX B-GLOSSARY

ABRASION RESISTANCE: Tests such as the Los Angeles Abrasion test are used to measure the ability of aggregate to resist crushing and pulverizing under conditions similar to those encountered in processing and use. Measuring resistance is an important component in the evaluation of the quality and prospective uses of aggregate. Hard, durable material is preferred for road building.

ABSORPTION CAPACITY: Related to the porosity of the rock types of which an aggregate is composed. Porous rocks are subject to disintegration when absorbed liquids freeze and thaw, thus decreasing the strength of the aggregate.

AGGREGATE: Any hard, inert, construction material (sand, gravel, shells, slag, crushed stone or other mineral material) used for mixing in various sized fragments with a cement or bituminous material to form concrete mortar etc., or used alone for road building or other construction. Synonyms include mineral aggregate and granular material.

CLAST: An individual constituent, grain or fragment of a sediment or rock, produced by the mechanical weathering of a larger rock mass. Synonyms include particle and fragment.

DELETERIOUS LITHOLOGY: A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road building aggregates. Such lithologies as chert, shale, siltstone and sandstone may deteriorate rapidly when exposed to traffic and other environmental conditions.

DEVONIAN: A period of the Paleozoic Era thought to have covered the span of time between 395 and 345 million years ago, following the Silurian Period. Rocks formed in the Devonian Period are among the youngest found in Ontario.

DIRT: See fines.

DOLOSTONE: A carbonate sedimentary rock consisting chiefly of the mineral dolomite and containing relatively little calcite (dolostone is also known as dolomite).

DRIFT: A general term for all unconsolidated rock debris transported from one place and deposited in another; distinguished from underlying bedrock. In North America glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

DRUMLIN: A low smoothly rounded, elongated hill, mound, or ridge composed of glacial materials. These landforms were deposited beneath an advancing ice sheet, and were shaped by its flow.

EOLIAN: Pertaining to the wind, especially with respect to landforms whose constituents were transported and deposited by wind activity. Sand dunes are an example of an eolian landform.

FINES: A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh seive (.074 mm). Also described informally as "dirt", these particles are in the silt and clay size range.

GLACIAL LOBE: A tongue-like projection from the margin of the main mass of an ice cap or ice sheet. During the Pleistocene Epoch several lobes of the Laurentide continental ice sheet occupied the Great Lakes basins. These lobes advanced and retreated numerous times during the Pleistocene, producing the complex arrangement of glacial material and landforms found in southern Ontario.

GRADATION: The proportion of material of each particle size, or the frequency distribution of the various sizes which constitute a sediment. The strength, durability, permeability and stability of an aggregate depend to a great extent on its gradation. The size limits for different particle sizes, as used by the Ontario Ministry of Transportation and Communications are as follows:

Boulder		>-256 mm
Gravel	cobble	64-256 mm
Gravel	pebble	4-64 mm
Gravel	granule	2-4 mm
Sand	coarse	.5-2 mm
	medium	.25-.5 mm
	fine	.074-.25 mm
Silt, clay		<.074 mm

GRANULAR BASE COURSE: Components of the pavement structure of a road, which are placed on the subgrade and are designed to provide strength, stability and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

H.L. (HOT LAID OR ASPHALTIC AGGREGATE) Bituminous, cemented aggregates used in the construction of pavements either as surface or bearing course (H.L. 1,3 and 4), or as binder course (H.L. 2,6 and 8) used to bind the surface course to the underlying granular base course.

LITHOLOGY: The description of rocks on the basis of such characteristics as colour, mineralogic composition and grain size. Generally, the description of the physical character of a rock.

MELTWATER CHANNEL: A broad, shallow, often terraced, valley produced by water flowing away from a melting glacier margin.

ORDOVICIAN: An earlier period of the Paleozoic Era thought to have covered the span of time between 500 and 435 million years ago.

PLEISTOCENE: An Epoch of the Quaternary Period, after the Pliocene of the Tertiary Period, including the time from approximately 1.8 million years ago to 7000 years ago. Much of the Pleistocene was characterized by extensive glacial activity and is popularly referred to as the "Great Ice Age".

POSSIBLE RESOURCE: Reserves estimates based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any samples or measurements. The estimates are based on assumed continuity or repetition for which there are reasonable geological indications.

SHALE: A fine-grained sedimentary rock formed by the consolidation of clay, silt or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, siltstone and mudstone.

SILURIAN: An early period of the Paleozoic Era thought to have covered the time between 435 and 395 years ago. The Silurian follows the Ordovician Period and precedes the Devonian Period.

SOUNDNESS: The ability of the components of an aggregate to withstand the effects of various weathering processes and agents. Unsound lithologies are subject to disintegration caused by the expansion of absorbed solutions. This may seriously impair the performance of road-building and construction aggregates.

TILL: : Unsorted and unstratified rock debris, ranging in size from clay to large boulders, deposited directly by glaciers, without subsequent reworking by water.

WISCONSINAN: Pertaining to the last glacial period of the Pleistocene Epoch in North America. It began approximately 85,000 years ago and ended approximately 7000 years ago. The glacial deposits and landforms of southern Ontario are predominantly the result of glacial activity during the Wisconsinan Stage.

APPENDIX C-GEOLOGY OF SAND AND GRAVEL DEPOSITS

The type, distribution and extent of sand and gravel deposits in southern Ontario are the result of extensive glacial and glacially influenced activity in Wisconsinan time during the Pleistocene Epoch, approximately 7 to 85 thousand years ago. The deposit types reflect the different depositional environments that existed during the melting and retreat of the continental ice masses, and they can readily be differentiated on the basis of their morphology, structure and texture. The deposit types are described below.

GLACIOFLUVIAL DEPOSITS

These deposits can be divided into two broad categories: those that were formed in contact with (or in close proximity to) glacial ice, and those that were deposited by meltwaters an appreciable distance from the ice margin.

Ice-Contact Terraces (ICT)

These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure of the deposits may be similar to that of outwash deposits, but in most cases the sorting and grading of the material is more variable and the bedding is discontinuous due to extensive slumping. The probability of locating large amounts of crushable aggregate is moderate, and extraction may be expensive due to the variability of the deposits both in terms of quality and grain size distribution.

Kames (K)

Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits producing internal structures characterized by bedding discontinuities. The deposits consist mainly of irregularly bedded and cross-bedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of land forms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" (IC) when detailed subsurface information is unavailable. Since kames often contain large amounts of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good quality, crushable aggregate. Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the occasional presence of excess fines (silt and clay-sized particles).

Eskers (E)

Eskers are low, sinuous ridges of sand and gravel deposited by meltwaters flowing in tunnels at the base of glaciers, or in channels on the ice surface. They vary greatly in size. Structurally, typical eskers consist of a central core of poorly sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified sand and gravel. The deposits have a high probability of containing a large proportion of crushable aggregate, and since they are generally built above the surrounding ground surface, are convenient extraction sites. For these reasons esker deposits have been traditional aggregate sources throughout southern Ontario, and are significant component of the total resources of many municipalities.

Some planning constraints and opportunities are inherent in the nature of the deposits. Because of their linear nature, the deposits often extend across several property boundaries leading to unorganized extractive development at numerous small pits. On the other hand, because of their form, eskers can be easily and inexpensivley extracted and are amenable to rehabilitation and sequential land use..

Undifferentiated Ice-Contact Stratified Drift (IC)

This designation may include deposits from several ice-contact, depositional environments which often form extensive, complex landforms. It is not feasible to identify individual areas of coarse-grained material within such deposits due to their lack of continuity and grain-size variability. They are given a qualitative rating based on existing pit and other subsurface data.

Outwash (OW)

Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the ice lobes. They occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain-size distribution. Outwash deposited near the glacier's margin is much more

able in texture and structure. The probty of locating useful crushable aggregates in vash deposits is moderate to high depending how much information on size, distribution thickness is available.

ium (AL)

lluvium is a general term for clay, silt, sand, el or similar unconsolidated material deted during postglacial time by a stream as rted or semi-sorted sediment, on its bed or its flood plain. The probability of locating e amounts of crushable aggregate in alluvial osits is moderate, but it has generally low e due to the presence of excess silt and clayd material.

CIOLACUSTRINE DEPOSITS

ciolacustrine Beach Deposits (LB)

hese are relatively narrow, linear features ned by wave action at the shores of glacial s that existed at various times during the aciation of southern Ontario. Well developed strine beaches are usually less than 20 feet n) thick. The aggregate is well sorted and tified and sand-sized material often predomis. The composition and size distribution of deposit depends on the nature of the under- material. The probability of obtaining hable aggregate is high when the deposit is eloped from coarse-grained deposits such as oney till, and low when developed on fine- ned materials. Beaches are relatively narrow, ar deposits, so that extractive operations are n numerous and extensive.

iolacustrine Deltas (LD)

hese features were formed where streams or rs of glacial meltwater flowed into lakes and osited their suspended sediment. In southern ario such deposits tend to consist mainly of l and abundant silt. However, in near-ice and contact positions, coarse material may be ent. Although deltaic deposits may be quite e, the probability of obtaining coarse mater- generally low.

iolacustrine Plain (LP)

he nearly level surface marking the floor of extinct glacial lake. The sediments which prise the plain are predominantly fine to medium sand, silt and clay, and were deposited in relatively deep water. Lacustrine deposits are of generally low value as aggregate sources due to their fine grain size and lack of crushable material. In some aggregate-poor areas, lacustrine deposits may constitute valuable sources of fill and some granular base course aggregate.

GLACIAL DEPOSITS

End Moraines (EM)

These are belts of glacial drift deposited at, and parallel to, glacier margins. They frequently consist of ice-contact stratified drift and in such instances are often called kame moraines. Kame moraines frequently result from deposition between two glacial lobes (inter-lobate moraines). The probability of locating aggregates within such features is moderate to low. Exploration and development costs are high. Moraines may be very large and contain vast aggregate resources, but the location of the best resource areas within the moraine is usually poorly defined.

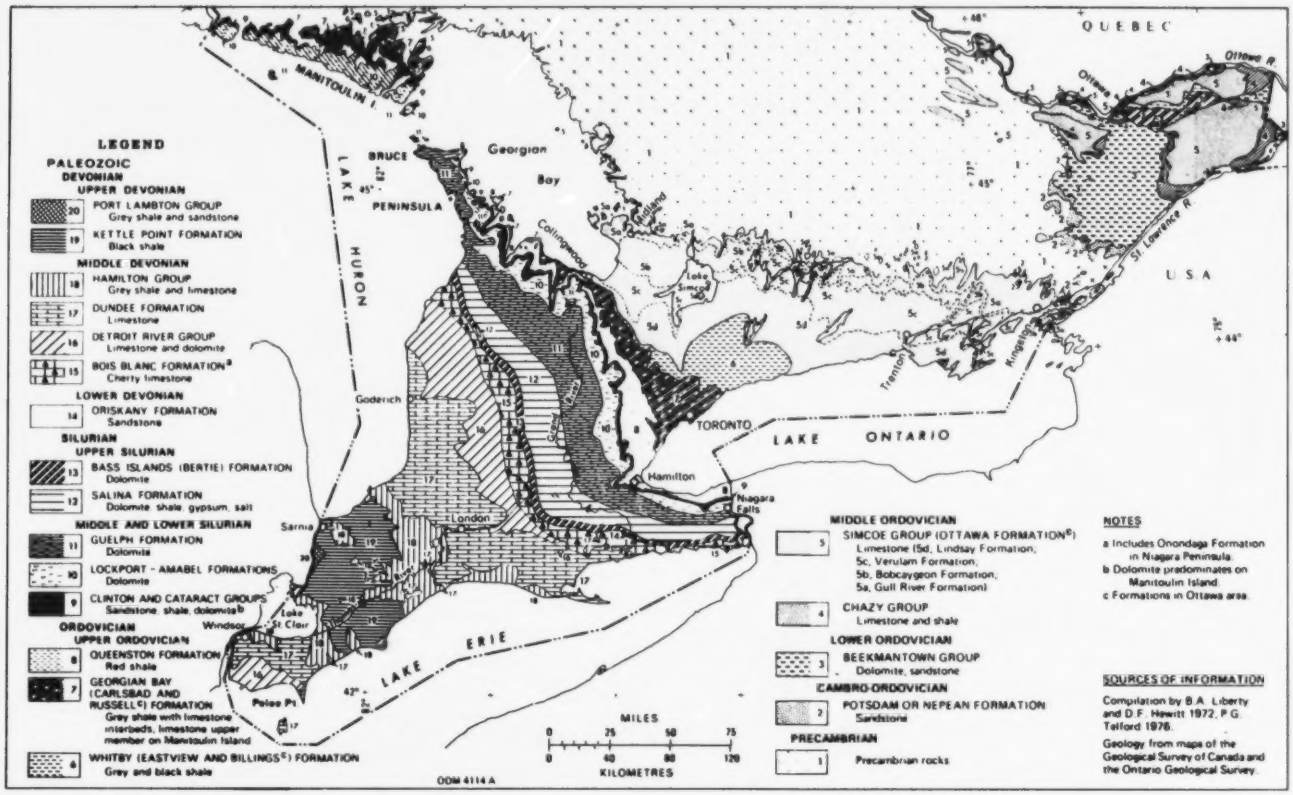


Figure 2 - Bedrock Geology of Southern Ontario.

BEDROCK SUITABLE FOR CRUSHED STONE PRODUCTS

Lockport-Amabel Formation (Middle Silurian)

Composition: Amabel Formation (Georgetown to the Bruce Peninsula); massive, fine crystalline dolostone, with reef facies dolostone near Georgetown. Lockport Formation (lateral facies equivalent of the Amabel Formation from Georgetown to Niagara Falls); thin to massive bedded, fine to medium-grained dolostone. Thickness: Amabel Formation; maximum observed thickness of 84 feet (25 m). Lockport Formation; up to 130 feet (40 m). Uses: The Lockport-Amabel Formation has been used to produce lime, crushed stone and building stone throughout its area of occurrence, and is a valuable aggregate resource. Los Angeles Abrasion Test: 21-35% loss; Soundness Test; 2.0% loss; Absorption: 0.4-1.6%.

Bass Islands Formation (Upper Silurian)

(Includes the Bertie Formation of the Niagara Peninsula) Composition: Medium to massive-bedded, aphanitic, brown dolostone with shaley partings. Thickness: 35 to 60 feet (10-18 m) near Hagersville. Uses: Quarried for crushed stone on the Niagara Peninsula at Fort Erie, Cayuga, Hagersville and Dunville. Los Angeles Abrasion Test: 17-35%; Absorption: 1.4%. Shaley portions are unsuitable for aggregate due to high soundness losses.

Bobcaygeon Formation (Middle Ordovician)

Composition: Compact, homogeneous, medium to thin-bedded fine-grained limestone with some argillaceous and shaley partings. Thickness: The lower unit is 40 to 72 feet (12 to 22 m) thick in the east and the remainder of the formation is 40 feet (12 m). Uses: Quarried at

Kirkfield and Marysville for crushed stone. The Bobcaygeon Formation has consistently acceptable quality for granular base course materials and concrete.

Bois Blanc Formation (Lower-Middle Devonian)

Composition: Brownish grey, medium-crystalline, medium to thin-bedded, cherty limestone, often fossiliferous. Limestone may be silty or sandy in places. Thickness: 9 to 200 feet (3 to 60 m). Uses: Quarried at Hagersville, Cayuga, and Port Colborne for crushed stone. High chert content makes much of the material unsuitable for concrete aggregate. Los Angeles Abrasion Test: 14-28% loss; Soundness Test: 4-10% loss; Absorption: 0.7-2.0%.

Dundee Formation (Middle Devonian)

Composition: Fine to medium crystalline, brownish grey, medium to thick-bedded, dolomitic limestone with shaley partings, sandy layers, and chert in some areas. Thickness: 60 to 160 feet (18 to 49 m). Uses: Quarried near Port Dover and Pelee Island for crushed stone. Used at St. Marys for portland cement. Los Angeles Abrasion Test: 22-32%; Absorption: 0-4%.

Gull River Formation (Middle Ordovician)

Composition: Member A - thin to thick-bedded, interbedded grey agrillaceous limestone and buff to green dolostone with a maximum thickness of 60 feet (18 m). Members B and C are dense, aphanitic limestones with argillaceous dolostone interbeds. Uses: Quarried at Kirkfield, Victoria County and Uthoff for crushed stone. The product is generally fresh and compact with good cubic-shaped factor, low clay content, low absorption and low soundness losses. Smooth particle surfaces may cause adhesion problems for asphalt. There is some alkali reactivity in a few of the layers.

Ottawa Formation (Middle Ordovician)

Composition: Lower Phase (Lowville and Pamela beds); shale, some sandstone and dolostone. Thickness: 100 feet (30 m). Middle Phase; (Hull, Rockland and Leray Beds); pure, thick-bedded, crystalline limestone. Thickness: 150 feet (46 m) near Ottawa. Upper Phase (Cobourg and Sherman Fall beds); pure and impure crystalline limestone with occasional to numerous shaley partings, 450-475 feet (137-145 m) thick near Ottawa. Uses: The Leray, Rockland and Hull beds have been quarried extensively for crushed stone and for building stone. In addition, the Hull beds are an excellent source of lime for cement production and agriculture lime.

Oxford Formation (Lower Ordovician)

Composition: Medium to thick-bedded, grey dolostone, with some shaley partings. Thickness: 240 feet (84 m). Uses: Quarried for crushed stone (road and concrete aggregate) at Ottawa, Brockville and Smiths Falls.

BEDROCK SUITABLE FOR LIME PRODUCTION AND OTHER CHEMICAL USES.

Detroit River Group (Middle Devonian)

Composition: Near Beachville, the group consists of medium to micro-crystalline, medium-bedded, high purity limestone. It grades northwards near St. Marys to soft, evenly bedded, fine-grained dolostone with bituminous laminae. Massive, porous, reef facies material also occurs to the north (Formosa Reef Limestone). Thickness: 100 feet (34 m) at Beachville, 350 feet (107 m) at Clinton. Uses: The most important source of high purity limestone in Ontario is the Lucas Formation of the Detroit River Group at Beachville. Detroit River limestone produces 80% of Ontario's cement. Its dolomitic reefal facies is also important for lime production to the north. It is generally unsuitable for crushed stone. The Anderdon Member of the Lucas Formation is quarried at Amherstburg for crushed stone.

Grenville Marble (Precambrian)

Composition: Recrystallized white limestone and dolostone, fine to coarse-grained, often of high chemical purity. Uses: Lime production, but also in small amounts for terrazo chips, poultry grit, decorative stone and building stone.

Guelph Formation (Middle Silurian)

Composition: Aphanitic to medium-crystalline, thick-bedded, soft, porous dolostone, characterized in places by extensive vuggy, porous reefal facies dolostone of high chemical purity. The Guelph Formation and the underlying Amabel Formation have a combined thickness of 200

feet (60 m) on the Niagara Peninsula and more than 400 feet (120 m) on the Bruce Peninsula. Uses: The main use is for dolomitic lime in the construction industry. It is quarried at Glen Christie and near Guelph.

Lindsay Formation (Middle Ordovician)

Composition: Lower Member - fine-crystalline, rubbly, nodular, weathering limestone. Upper Member, grey calcareous claystone with shaley partings and bioclastic layers. The rock is "soft" and weathers to rubble. Both members are characterized by low dolomite content and by numerous clayey partings. Uses: Quarried at Picton, Ogden Point, Colborne and Bowmanville for lime. It is generally unsuitable for crushed stone, concrete aggregate or granular base course.

Verulam Formation (Middle Ordovician)

Composition: Fossilferous, pure to argillaceous limestone and interbedded calcareous shale. The rock is not resistant to erosion and often weathers to rubble. Thickness: 200-300 feet (61-70 m). Uses: Quarried at Picton, Ogden Point and Mara Township for lime. It is unsuitable for crushed stone due to clay impurities and frequent clayey interbeds, low abrasion resistance, high soundness losses and poor freeze-thaw resistance.

BEDROCK SUITABLE FOR BRICK AND TILE MANUFACTURE

Georgian Bay Formation (Upper Ordovician)

(Formerly known as the Meaford-Dundas and Blue Mountain shales in the Toronto and Bruce Peninsula areas). Composition: Soft, fissle, blue-grey shale with occasional limey or sandy lenses. Thickness: 640 feet (196 m) at Toronto. Uses: Five producers in Metro Toronto and Cooksville (Guillet 1967) produce brick and structural tile. Light-weight aggregate is also produced at Streetsville by heat expansion of the shale.

Hamilton Group (Middle Devonian)

Composition: Grey shale with interbeds of crystalline and cherty limestone. The Group comprises six formations. Only the Arkona is of commercial value. It is a soft, light grey, calcareous shale which is plastic and easily worked when wet. Thickness: 80 to 300 feet (24 to 91 m). Uses: The Arkona Formation is extracted at Thedford and near Arkona for production of drainage tile and brick.

Queenston Formation (Upper Ordovician)

Composition: Red, thin to thick-bedded, sandy to argillaceous shale with green mottling and banding. Thickness: 400 to 500 feet (120 to 150 m). Uses: There are 12 large shale quarries developed in the Queenston Formation in the Toronto-Hamilton region (Guillet 1967) and one at Russel, near Ottawa. All produce brick for construction. The Queenston Formation is the most important source material for brick manufacture in the Province.

BEDROCK SUITABLE FOR OTHER INDUSTRIAL PRODUCTS

Nepean (Potsdam) Formation (Cambro-Ordovician)

Composition: Creamy, coarse-grained, silica sandstone. Uses: Quarried throughout its area of outcrop for building stone, decorative stone, abrasives, and for glass making.

Salina Formation (Upper Silurian)

Composition: Grey and red shale, brown dolomite, and, in places, salt, anhydrite and gypsum. The formation consists predominantly of evaporite deposits with up to eight members identified. Uses: Gypsum is mined at Hagersville, Caledonia and Drumbo. Salt is mined at Goderich and is produced from brine wells at Amherstburg, Windsor and Sarnia.

Whitby Formation (Upper Ordovician)

(Formerly known as Collingwood shale near Toronto). Composition: Brown-black fissile shale. Uses: Quarried at Bowmanville for use in cement production. Testing indicates that the Whitby Formation may produce satisfactory light-weight expanded aggregate.

Ontario

ONTARI
AGGREGA

MON

DU

BED

Mile 1
Metres 100

NT

© OMNR-OGS 197

PALEOZOIC

MIDDLE
G

L

CLIN

ORDOVIC
UPPER O
C

CLINTON AND CATARACT GROUPS
MANITOULIN FORMATION

GUELPH FORMATION

AMABEL FORMATION

AMABEL FORMATION

GEORGIAN BAY FORMATION

QUEENSTON FORMATION

SHELDON HILL

MILL HILL

NOTTAWA HILL

H I L L S

SIMCOE CO

ADJALA TP
MONO TP

Violet Hill
Primrose
Granger
Elba
Elder
Relessey
Sheldon Creek
Gravel Pit
Radio 100
Microwave 100
Auto Wrecker
Ditch
Centre

MULMUR TP
MONO TP

GP

50
25
10

Ministry of Natural Resources
Ontario

Hon. James A.C. Auld
Minister

Dr. J.K. Reynolds
Deputy Minister

ONTARIO GEOLOGICAL SURVEY
AGGREGATE RESOURCES INVENTORY

MONO TOWNSHIP

DUFFERIN COUNTY

MAP 3
BEDROCK RESOURCES

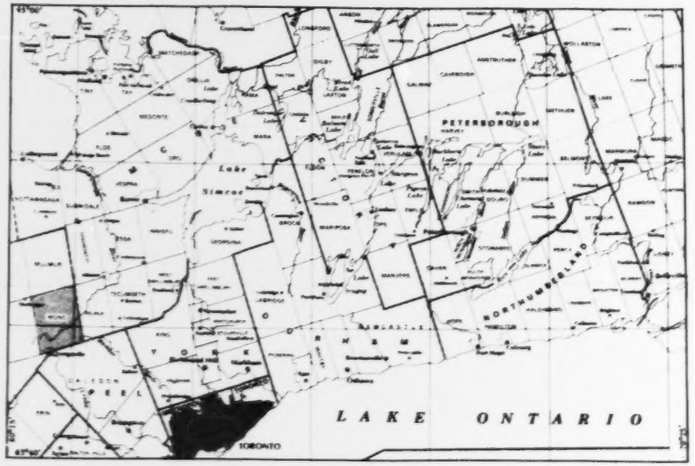
Scale: 1:50,000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 A/1, 40 P/16, 31 D/4W, 31 M/13W

© OMNR-OGS 1979



LEGEND

PALEOZOIC

MIDDLE AND LOWER SILURIAN

GUELPH FORMATION
Dolostone

LOCKPORT-AMABEL FORMATIONS
Dolostone

CLINTON AND CATARACT GROUPS
Sandstone, shale, dolostone

ORDOVICIAN

UPPER ORDOVICIAN

QUEENSTON FORMATION
Red shale

GEORGIAN BAY FORMATION

AMABEL FORMATION

AMABEL FORMATION

H I L L S

QUEENSTON FORMATION

NOTTAWA HILL

ADJALA TP
MONO TP

Elba

Relessey

Auto Wrecker

Gravel Pit

Ditch

GP

Centre

Camilla

Dams

Dam

Woodside

HOCKLEY VALLEY

Ski Lifts

Ski Lift

Lucille

Bailey

Glen Cross

Ontario Hydro Training Center

Radio

Cardwell

CLINTON AND CATARACT GROUP MANITOULIN FORMATION

Foundry

Nottawasaga River

Microwave 160

Mount Allens Lakes

QUEENSTON FORMATION

AMARANTH TP

MONO TP

Salem

CLINTON AND CATARACT GROUPS MANITOULIN FORMATION

Islands Lake

Gravel Pit

Dam

Cemetery

Drive-in Theatre

Fish Hatchery

AMABEL FORMATION

Auto Wrecker

CALEDON

Transformer Station

ESCARPMENT

PALEOZ

MID

ORDO
UPP

Ge

Dr

Iso

Be

Be
See

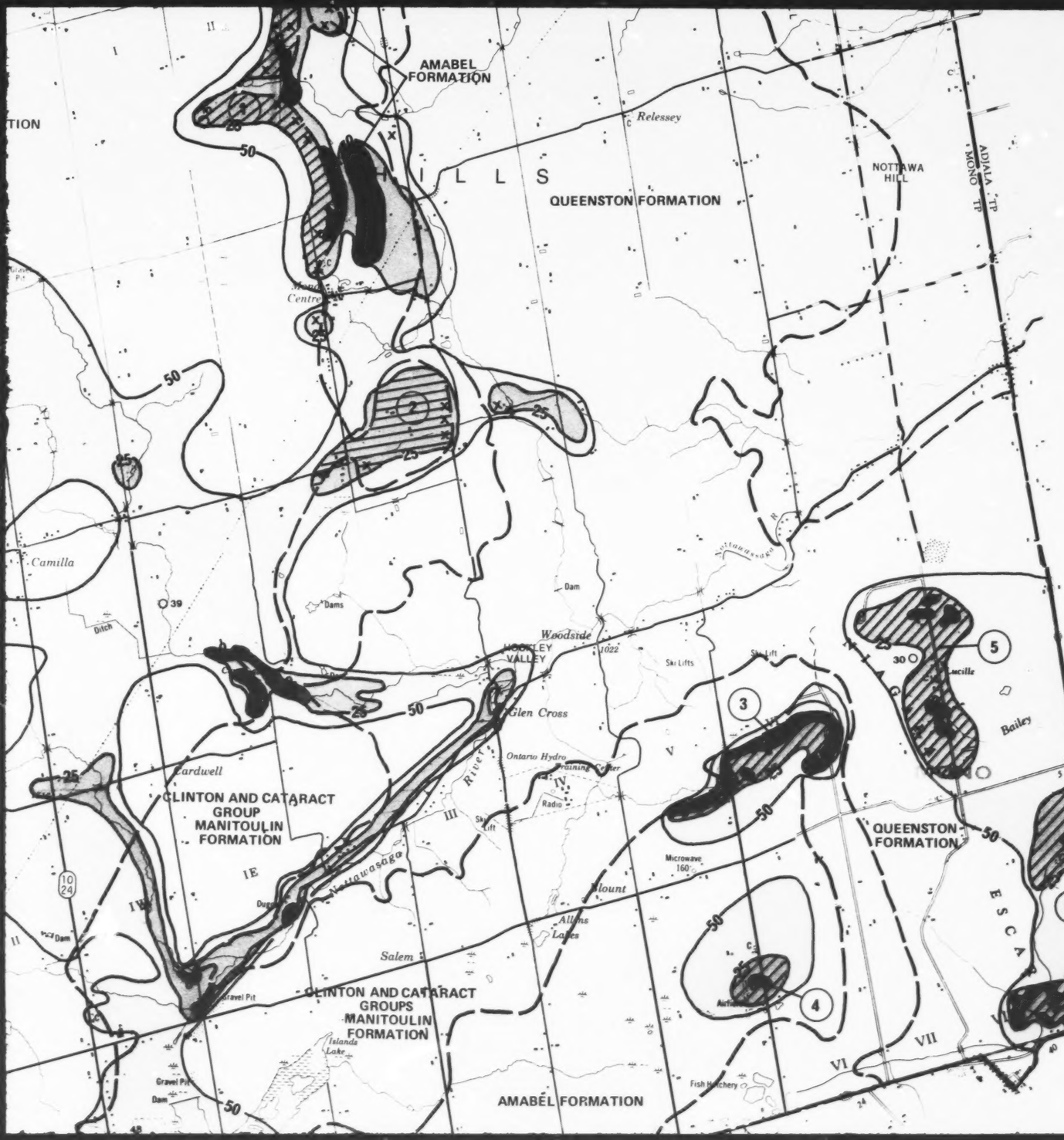
Be
den

Sel

Sel
(in

Base map by C
Ministry of N
License data fi
Natural Reso
Material perfo
Section, Onta
Selected drillin
Ontario Mini
Geological Su

Geology by W


AMABEL FORMATION
Relessey
HILLS
NOTTAWA HILL
QUEENSTON FORMATION
ADJALA TP
MONO TP
Camilla
Dam
Dams
Woodside
HOCKLEY VALLEY
Ski Lifts
Glen Cross
Ontario Hydro Training Center
Cardwell
CLINTON AND CATARACT GROUP MANITOULIN FORMATION
Nottawasaga River
Radio
Microwave
Mount Allans Lakes
Salem
Gravel Pit
CLINTON AND CATARACT GROUPS MANITOULIN FORMATION
Islands Lake
AMABEL FORMATION
Fish Hatchery
Bailey
QUEENSTON FORMATION
ESCARPMENT
50
25
39
30
10
24

LEGEND

PALEOZOIC

MIDDLE AND LOWER SILURIAN

GUELPH FORMATION
Dolostone

LOCKPORT-AMABEL FORMATIONS
Dolostone

CLINTON AND CATARACT GROUPS
Sandstone, shale, dolostone

ORDOVICIAN

UPPER ORDOVICIAN

QUEENSTON FORMATION
Red shale

GEORGIAN BAY FORMATION
Grey shale with limestone interbeds; limestone upper member on Manitoulin Island

WHITBY FORMATION
Grey and black shale

SYMBOLS

- Geological boundary.
- 25 — Drift thickness contour line (25 foot (8 m) interval).
- x — Isolated bedrock outcrop.
- Bedrock within 3 feet (1 m) of surface: see Table 4.
- Bedrock covered by 3 to 25 feet (1 m to 8 m) of overburden: see Table 4.
- Bedrock covered by 25 to 50 feet (8 m to 15 m) of overburden: see Table 4.
- Selected bedrock resource area; Deposit number: see Table 6.
- O 27 — Selected drilling location indicating reported depth to bedrock (in feet).

SOURCES OF INFORMATION

Base map by Cartography Section, Lands and Waters Group, Ontario Ministry of Natural Resources.
License data from District and Regional Offices, Ontario Ministry of Natural Resources.
Material performance data from Pavement Design and Management Section, Ontario Ministry of Transportation and Communications.
Selected drilling data from Ontario Ministry of the Environment, Ontario Ministry of Transportation and Communications, Ontario Geological Survey, Geological Survey of Canada.

MONO

ORDOVICIA
UPPER OR
QU
GE
WH

Geological
25 Drift thick
x Isolated b
Bedrock w
Bedrock
see Table
Bedrock
den see T
Selected b
27 Selected
(in feet)

SOU

Base map by Cartogra
Ministry of Natural
License data from D
Natural Resources
Material performance
Section, Ontario M
Selected drilling dat
Ontario Ministry o
Geological Survey

Geology by W.R. C
Q.H.J.
Q.H.J.
Q.H.J.

Compilation and dra

Fraser, J.Z. and K
1979: Aggregate
Southern
Inventory
1:50 000.

ISSUED 1979

MONO

ORDOVICIAN

UPPER ORDOVICIAN

QUEENSTON FORMATION
Red shale

GEORGIAN BAY FORMATION
Grey shale with limestone interbeds; limestone upper member on Manitoulin Island

WHITBY FORMATION
Grey and black shale

SYMBOLS

- Geological boundary.
- 25 — Drift thickness contour line (25 foot (8 m) interval).
- x — Isolated bedrock outcrop.
- Bedrock within 3 feet (1 m) of surface: see Table 4.
- Bedrock covered by 3 to 25 feet (1 m to 8 m) of overburden: see Table 4.
- Bedrock covered by 25 to 50 feet (8 m to 15 m) of overburden: see Table 4.
- Selected bedrock resource area; Deposit number: see Table 6.
- O 27 — Selected drilling location indicating reported depth to bedrock (in feet).

SOURCES OF INFORMATION

Base map by Cartography Section, Lands and Waters Group, Ontario Ministry of Natural Resources.
License data from District and Regional Offices, Ontario Ministry of Natural Resources.
Material performance data from Pavement Design and Management Section, Ontario Ministry of Transportation and Communications.
Selected drilling data from Ontario Ministry of the Environment, Ontario Ministry of Transportation and Communications, Ontario Geological Survey, Geological Survey of Canada.

Geology by W.R. Cowan, 1976
Q.H.J. Gwyn 1972, 1975
Q.H.J. Gwyn and J.Z. Fraser, 1975 a,b.
Q.H.J. Gwyn and S. White, 1973
P.G. Telford, I.J. Bond and B.A. Liberty, 1975 a,b,c.
O.L. White, 1975

Compilation and drafting by C.M. Kwiatkowski 1978

Fraser, J.Z. and Kwiatkowski, C.M.
1979: Aggregate Resources Inventory of Mono Township, Dufferin County, Southern Ontario; Ontario Geological Survey, Aggregate Resources Inventory Paper 1, 32p., 6 tables. Accompanied by 3 maps, scale: 1:50 000.

ISSUED 1979

Ontario

ONT
AGGRE

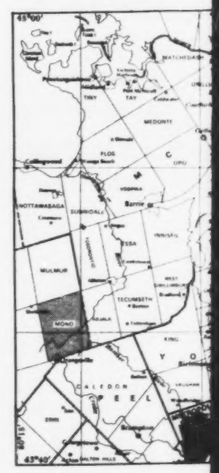
MO

D

SELECTE
R

Mile 1
Metre

© OMNR-OGS



Geol

Selec
Depo

Selec

Selec

2

Mulmur

VIII

SHELDON HILL

DUFFERIN CO

SIMCOE CO

Violet Hill

MULMUR TP

MONO TP

GP

Gravel Pit

Radio 100

Primrose

10

SHELDON HILL

GP

VII

VI

Sheldon

Elder

M O N O

IV

III

II

I

Granger

Microwave 100

11

Elba

II

III

MILL HILL

MILL HILL

Relessey

H I L L S

NOTTAWA HILL

ADJALA TP

MONO

9

Auto Wrecker

8

Gravel Pit

7

6

Mono Centre

Ditch

Ministry of Natural Resources

Ontario

Hon. James A.C. Auld
Minister

Dr. J.K. Reynolds
Deputy Minister

ONTARIO GEOLOGICAL SURVEY
AGGREGATE RESOURCES INVENTORY

MONO TOWNSHIP

DUFFERIN COUNTY

MAP 2
SELECTED SAND AND GRAVEL RESOURCE AREAS

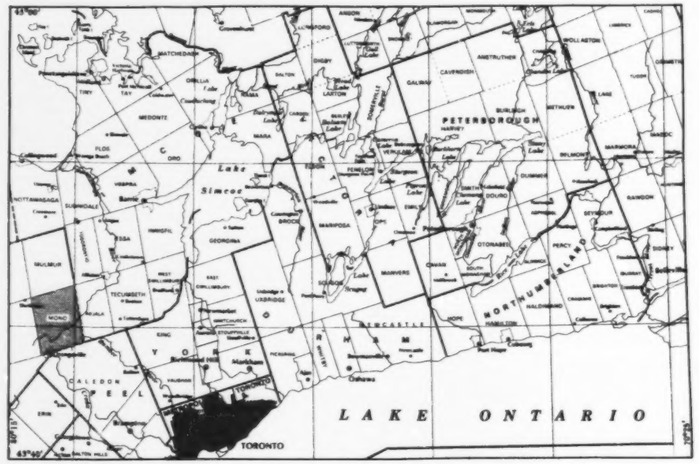
Scale: 1:50,000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 A/1 40 P/16 31 D/4W
31 M/13W

© OMNR-OGS 1979



SYMBOLS

- Geological boundary.
- Selected sand and gravel resource area; Primary significance; Deposit number: see Table 3.
- Selected sand and gravel resource area; Secondary significance.
- Selected sand and gravel resource area; Tertiary significance.

MONO

Geological

Selected sa
Deposit num

Selected sand

Selected san

Licenced pr

SOURCE

Base map by Cartography
Ministry of Natural Reso
License data from Distric
Natural Resources.
Material performance dat
Section, Ontario Ministr
Selected drilling data fr
Ontario Ministry of Tra
Geological Survey, Geol

Geology by W.R. Cowa
O.H.J. Gwy
Q.H.J. Gwy
Q.H.J. Gwy

Compilation and draftin

Fraser, J.Z. and Kwia
1979: Aggregate Re
Southern On
Inventory Pa
1:50 000.

ISSUED 1979

Geological boundary

Selected sand and gravel resource area; Primary significance. Deposit number: see Table 3.

Selected sand and gravel resource area. Secondary significance.

Selected sand and gravel resource area; Tertiary significance.

Licenced property boundary; Property number: see Table 2.

SOURCES OF INFORMATION

Base map by Cartography Section, Lands and Waters Group, Ontario Ministry of Natural Resources.

License data from District and Regional Offices, Ontario Ministry of Natural Resources.

Material performance data from Pavement Design and Management Section, Ontario Ministry of Transportation and Communications.

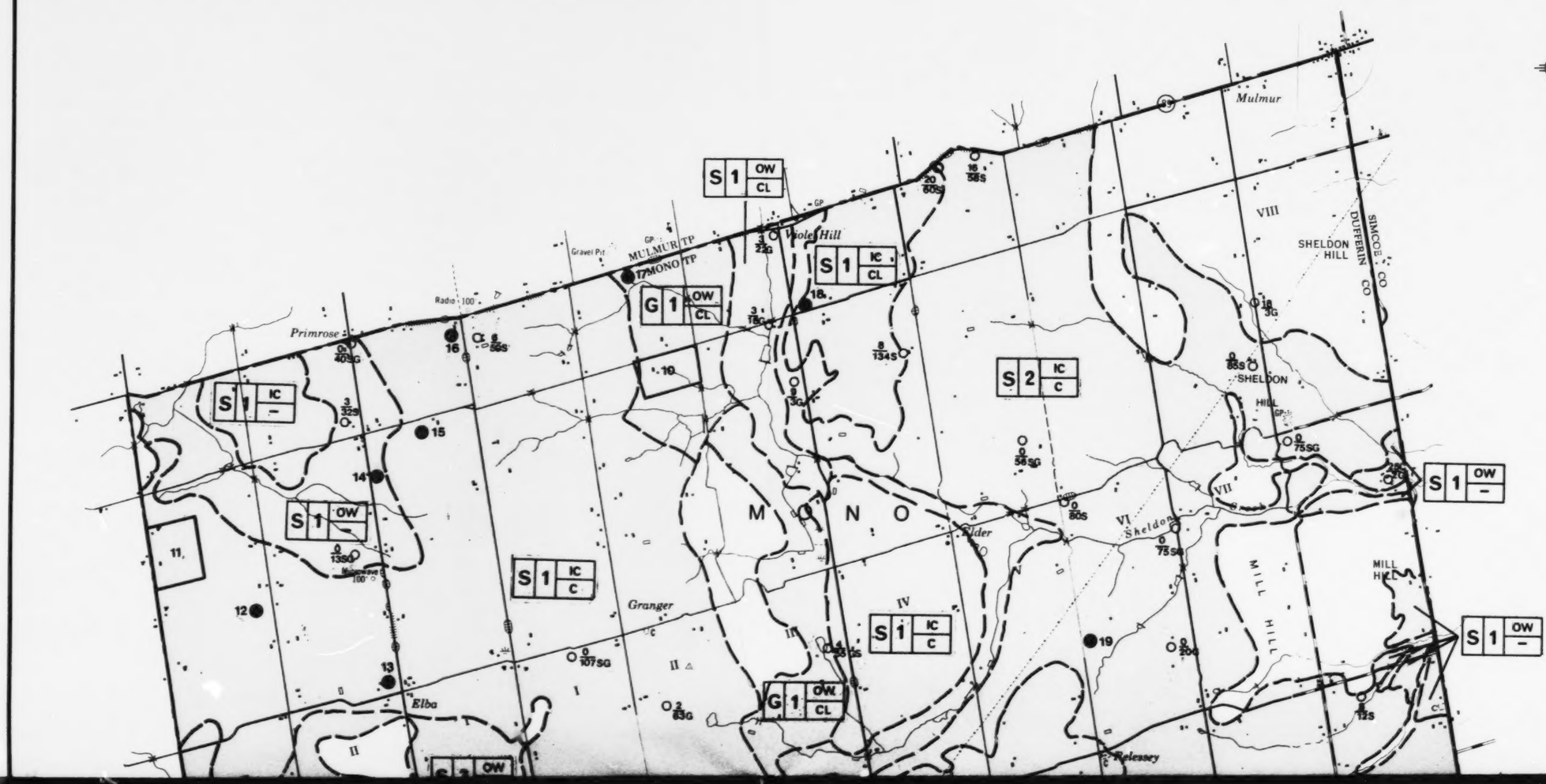
Selected drilling data from Ontario Ministry of the Environment, Ontario Ministry of Transportation and Communications, Ontario Geological Survey, Geological Survey of Canada.

Geology by W.R. Cowan, 1976
Q.H.J. Gwyn, 1972, 1975
Q.H.J Gwyn and J.Z. Fraser, 1975 a,b.
Q.H.J. Gwyn and S. White, 1973
P.G. Telford, I.J. Bond and B.A. Liberty, 1975 a,b,c.
O.L. White, 1975

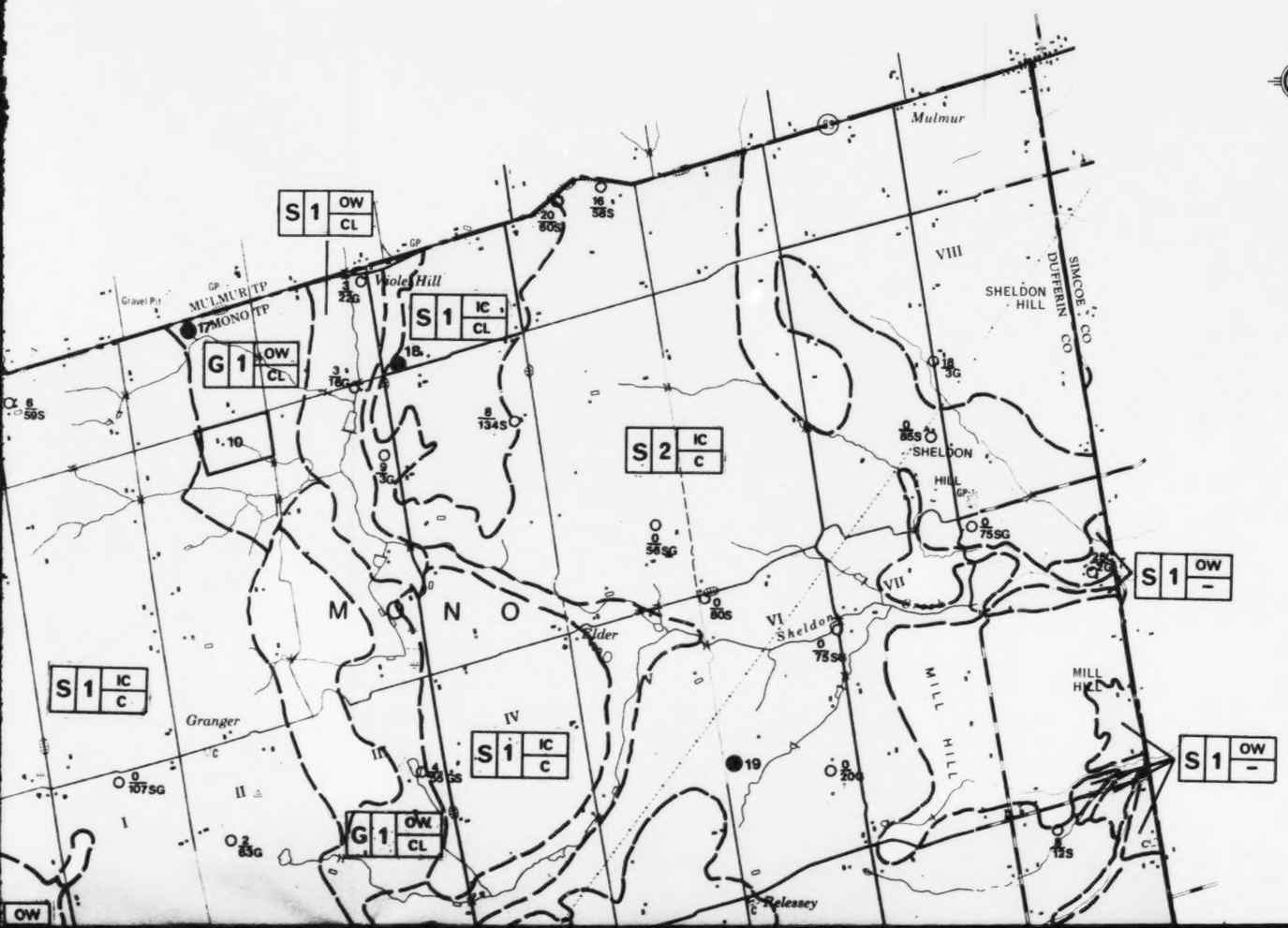
Compilation and drafting by C.M. Kwiatkowski 1978

Fraser, J.Z. and Kwiatkowski, C.M.
1979: Aggregate Resources Inventory of Mono Township, Dufferin County, Southern Ontario; Ontario Geological Survey, Aggregate Resources Inventory Paper 1, 32p., 6 tables. Accompanied by 3 maps, scale: 1:50 000.

ISSUED 1979


Mulmur
MULMUR TP
17MONO TP
Violet Hill
Primrose
Granger
Elba
Elder
Sheldon
SHELDON HILL
SHELDON
HILL GP
MILL HILL
MILL HILL
VIII
VII
VI
IV
II
I
SIMCOE CO
DUFFERIN CO
Radio 100
Gravel Pit
Releasey
M O N O
S 1 OW CL
S 1 IC CL
G 1 OW CL
S 1 IC —
S 1 OW —
S 1 IC C
S 2 IC C
G 1 OW CL
S 1 IC C
S 1 OW —
G 2 OW
10
11
12
13
14
15
16
18
19

© OMNR



Ministry of Natural Resources

Ontario

Hon. James A.C. Auld
Minister

Dr. J.K. Reynolds
Deputy Minister

ONTARIO GEOLOGICAL SURVEY
AGGREGATE RESOURCES INVENTORY

MONO TOWNSHIP

DUFFERIN COUNTY

MAP 1
DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

Scale: 1:50,000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference. 41 A/1, 40 P/16, 31 D/4W, 31 M/13W

© OMNR-OGS 1979

NOTTAWA HILL

ADJALA TP

MONO

AMARANTH TP

Camilla

Cardwell

Foundry

Blount

Allens Lakes

Bailey

Lucille

Glen Cross

Auto Wrecker

Ski Lift

Ski Lifts

Training Center

Radio

Microwave

Dam

Dams

Ditch

Dugout

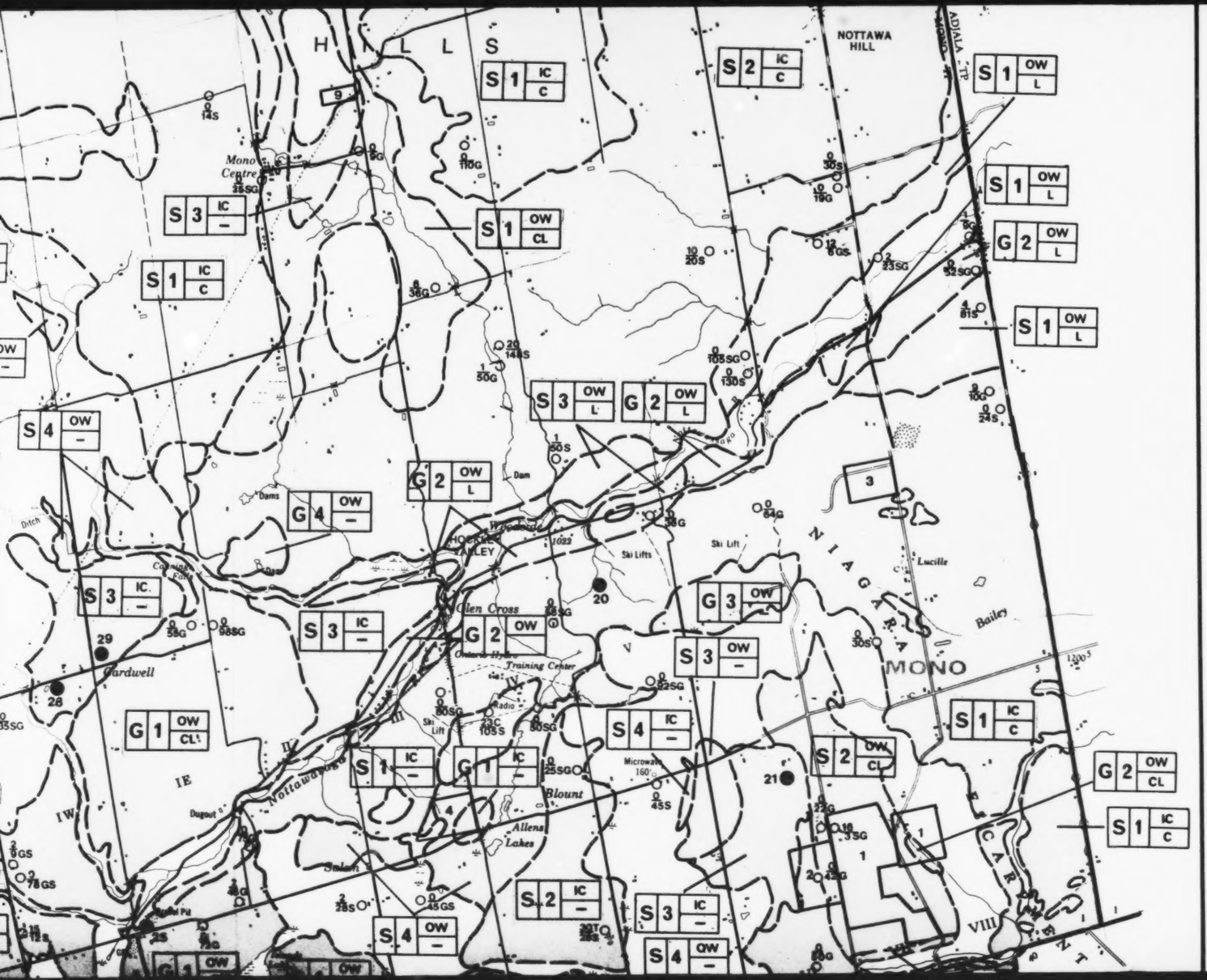
Sakawi

Notawasaga

NIAGARA

CAR

VIII



SYMBOLS

Geological boundary Shading denotes deposit area.

Deposit symbol : see below.

Licenced property boundary; Property number: see Table 2.

Sand or gravel pit; Property number: see Table 2.

Selected drilling location indicating thickness of overburden overlying reported thickness of granular materials.(in feet).

DEPOSIT SYMBOL

Deposits are identified by gravel content, thickness class, deposit type and quality indicators. Gravel content is expressed as percentage of crushable material. Class are based on potential aggregate tonnage per acre and are designated numerically. Type refers to geologic origin. Quality modifiers indicate variations in grain size distribution and lithology.

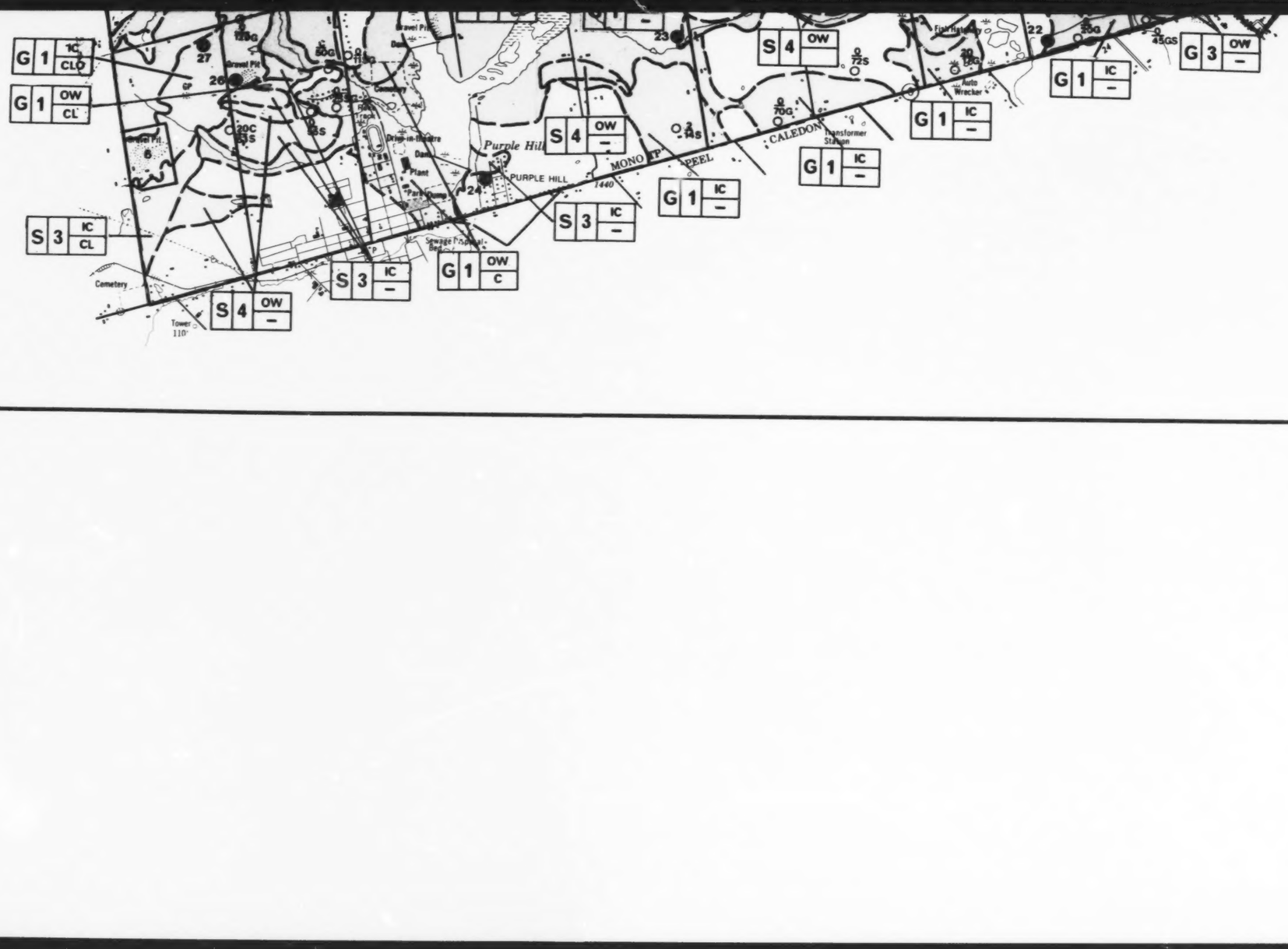
Gravel Content	Thickness Class	Geological Type / Quality Indicators

Gravel Content

G	Greater than 35% gravel.
S	Less than 35% gravel.
–	Requires investigation.

Thickness Class

Class	Average Thickness in feet (metres)	Tons per acre (Tonnes per hectare)
1	greater than 20 (> 6)	greater than 50,000 (> 18,500)
2	10-20 (3-6)	25,000-50,000 (9,000-18,500)
3	5-10 (1.5-3)	12,500-25,000 (4,500-9,000)
4	less than 5 (< 1.5)	less than 12,500 (< 4,500)



MONO

Geological

IC

ICT
K
E
EM
(see Appe

Quality In

C
L
O

–

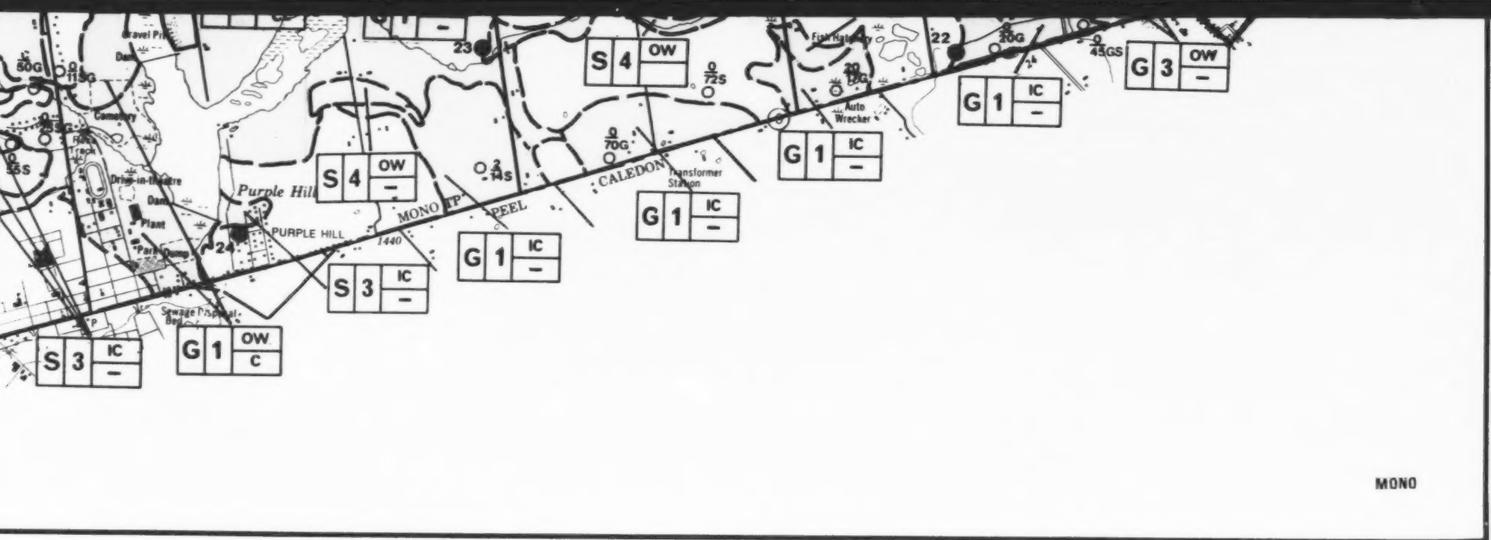
Base map
Ministry
License da
Natural R
Material p
Section
Selected d
Ontario
Geologica

Geology b

Compilati

Fraser, J
1979: A

ISSUED 1



MONO

Geological Type

IC	Undifferentiated Ice-Contact Stratified Drift	OW	Outwash
		LB	Lacustrine Beach
ICT	Ice-Contact Terrace	LP	Lacustrine Plain
K	Kame	D	Delta
E	Esker	AL	Older Alluvium
EM	End Moraine		

(see Appendix C for Deposit Type descriptions.)

Quality Indicators

	No known limitations present
C	Clay and/or silt (fines) present in objectionable quantities
L	Deleterious lithologies present
O	Oversize particles or fragments present in objectionable quantities
–	Requires investigation

SOURCES OF INFORMATION

Base map by Cartography Section, Lands and Waters Group, Ontario Ministry of Natural Resources.
License data from District and Regional Offices, Ontario Ministry of Natural Resources.
Material performance data from Pavement Design and Management Section , Ontario Ministry of Transportation and Communications.
Selected drilling data from Ontario Ministry of the Environment, Ontario Ministry of Transportation and Communications, Ontario Geological Survey, Geological Survey of Canada.

Geology by W.R. Cowan, 1976
O.H.J. Gwyn, 1972, 1975
Q.H.J. Gwyn and J.Z. Fraser, 1975a,b.
Q.H.J. Gwyn and S. White, 1973
P.G. Telford, I.J. Bond and B.A. Liberty, 1975a,b,c.
O.L. White, 1975

Compilation and drafting by C.M. Kwiatkowski 1978

Fraser, J.Z. and Kwiatkowski, C.M.
1979: Aggregate Resources Inventory of Mono Township, Dufferin County, Southern Ontario; Ontario Geological Survey, Aggregate Resources Inventory Paper 1, 32p., 6 tables. Accompanied by 3 maps, scale: 1:50 000.

ISSUED 1979